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Vol. 65, No. 2, Pages 9-16 Particles and Fields-

Vol. 65 No. 2 January 10, 1984

Transactions, American Geophysical Union

January 10, 1984

# Magnetosphere

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#### Seismology

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6393 General SCISNICITY AND TECTOMICS OF THE STEEGLER'S CORGE AREA, Hilear Bungus (NISF/NORSAR, Foet Box 51, N-2007 Kieller, 'ortwis'), Abduell A. Enko (Dopt. of Geology, University of Pir se Salasa, Tanzania) orday), Abduell A. Enko (Dept. of Geology, University of Par os Salsan, Tamenda).

A nicrowarthywate network with 6 stations and a distance of about 10 ha has been in operation in the Stigaler's torge area (Ruiiji Sesin). Tensamia, between 171d and 1981. The network, which used radio beleentry and digital recording at 10 %s hased on a triggering barton, has twooded a large custor of telescismic and for home or tridgering that the second local one within the network. Most of the locally recorded darthquabos are in the regnitude range 0-4 resourch on a duration magnitude scale which has been dresinged for the area, a scale which also satisfactured of the state of the second resided for the area, a scale which also satisfactured for the area of the strength of the second range of the state of the strength of the second satisfacture of the focal setaletty shows a fairly stable ratery, and a detailed furel sechasian study within the out active zone shows a predominance for normal satisfact with cast-west extensional seventh of the sate of the second correlation between the naiseletty and locally supped faults, and it is also cumsistent with orthoologies of the regional sectorics of the Fast African Rift System. (Microscithyse, Scale sechanters, 1812)

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Phio Politics

WHELDES FOR DESONED INSPITUTIONAL ANALYSIS

IN THE RESOURCES FLANTING

H. N. Ingram (Department of Political Sqionca, Strain, Strain, Strain, S. Manq. G. D. Mentherford, S. J. Corpnar Institutional factors are often among the cost (craidable obserted as the development, and implementation of Famelble Marg Tembures

programs. Guidelines for gethering and analyzing information on institutional factors as part of water resource planning and evaluation activities are presented. In approaching the analysis of current institutional errangements, analysis should pay particular attention to (1) the accors and their stakes in the decision-making process; (7) the political and decision-making resources actors have svailable to pursue their interests; and (1) the bissues of the alternative decision-making structures through which various weter resource decisions are mades. While testitutional arrangements implementation, it is of most use when it goes beyond a description and easilysis of current institutional arrangements to sussessee the subject to the problems indecision that can be applied to the problems identified. (Institutional analysis, planning, resource assessments, decision-making).

#### Tectonophysics

for identifying a weak, along harmonic time sig-nel in the presence of record gaps, we assume the signal in phase coherent for the full time series across the gaps and parform Youriar analysis of the full data sequence. The signal-to-noise ratio is improved by 1/N over the signal-to-noise ratio is improved by 1/N over the case where individual gapped segments are summed, where N is the number of regments. Analysis of the recordings from the South Pols both bafore and after the Sumbawa earthquake shows no spectral line identifiable with the pendulum mode that is shows the noise lavel. J. Gephys. Res., Earth, Paper 381843

#### Information Related to Geographic Region

9199 General (Ablatelica) CENTRAL TRANSANTARCTIC MOUNTAINS MOWNARINE

CENTRAL TRANSANTARCTIC MOUNTAINS NORMARINE DEPOSITS
P. Tasch (Goology Dapartment, Wichita State University (Withita, Kaness, 67208), E.L. Gafford Jurasaic bioetratigraphic amples were taken in interbeds between successive disbase flows in the Beambarrs Glacier stars, Bifurard Beights-BH. Room Feak, Antercties. This permitted detailed reconstruction through time, of the lacustrine biota, variable peleclimology, geochronology of the interbeds and the geochemistry of the two flows at BH. The lake lasted 306120 years (detarmined by seasonal coachestracans and isminas counts). This detainstion gave a time-fix to the microprobe analysis of the two flows: dider flow, higher Critthan youngar, the latter with more SiO, and MgO than the older. An increased flow) were determined by two methods geochemistry phosphate, method. Both were checked by successive mountarine couchestraces generations. (Limology, Secchomology, volcasology, secchemistry), Anterctic Res. Ser., Vol. 16, Apper 10012 interctic Res. Ser., Vol. 16, Paper 100122 .

# ews

In Congress

## **NOAA Budget Set**

In late November, President Ronald Reagan signed into law the National Oceanic and Atmospheric Administration (NOAA) budget, which is part of the appropriations bill for the Departments of Commerce, Justice, State, the Judiciary, and related agencies; at the same time, he also signed into law an amendment attached to that bill that prohibits the sale of the weather satellites (Eos., May 17, 1983, p. 377, and March 22, 1983, p. 113). cialization of the land remote sens ing satellite system is still being considered,

As a result of the conference between the House of Representatives and the Senate appriations committees, the appropriation propriations committees, making with a program level of \$1073.1 million. The appropriation is the money that comes from the federal treasury; the program level represents all of the funds—including treasury funds, transfers, residuals, etc.—actually available for the program. Strictly in terms of dollars, the total fiscal 1984 NOAA appropriation is almost level with the fiscal 1983 appropriation of \$1000.9 million. In fiscal 1984, NOAA's research core, called Operations, Research, and Facilities (ORF), receives an appropriation of \$988.2 million, with a program level of \$1014.8 million.

Table I compares the 1983 base, the Reagan budget proposal, and the final conference program levels for ORF. The 1983 base, which is a conservative estimate of spending, is lower than the actual 1983 expenditures. which were being calculated as Eos went to

The satellite and environmental data and information services activity gets the biggest

Ocean and Coastal Programs

Ocean research

Ocean services

Nonliving marine resources

Coastal zone management

Atmospheric Programs

Satellite services

Satellite systems

Program Support

Total, ORF

Mapping, charting, & geodesy

Marine Fishery Resource Programs

Public warning & forecast services

Satellite & Environmental Data &

Information Services

Data & information services

Atmospheric & hydrologic research

<sup>2</sup>See *Eos*, February 15, 1983, p. 65.

dollar increase, much of which goes to maintaining various satellite systems. Included in the increase for the satellite systems subactivity is an additional \$20.4 million for the launch of Landsat D'; President Reagan added these funds to his initial budget request. Funding for data and information services. however, drops to a program level of \$22.8

Most of the increase for atmospheric programs, which accounts for more than onethird of ORF funds, goes to the public warning and forecast services subactivity. Within this subactivity, \$10 million is slated for NEX-RAD, the next generation weather radar system to improve severe weather forecasting (Ess., June 14, 1983, p. 411). Like the funds for the Landsat D' launch, this \$10 million was amended to the president's initial re-

In the ocean and coastal programs activity, Congress restored funds to the Sea Grant program, which President Reagan had proposed to eliminate. Coastal zone management, which was included in ocean and coastal programs in the Reagan budget request, was removed entirely from ORF by Congress and established as a separate account.

The appropriations bill for Commerce, Justice, State, the Judiciary, and related agencies (H.R. 8222) was signed into law (P.L. 98-166) on November 28 by President Reagan. The bill included a rider, attached on the bill's way through Congress, that prohibited the federal government from spending money to solicit bids to carry out the proposed sale of the meteorological satellites. When the bill reached his desk, Reagan had the option of rejecting the budgets for all of those agencies or signing the bill. He opted to sign. This blocks only the sale of the weather satellites; plans to sell the land remote sensing satellite system are still under way by the Source Evaluation Board on Civil Space Remote Sens-

Reagan FY84

Proposal

23,452

13,237

6,056

148,508

147,318

157,761

22,783

252,023

111,678

117,125

92,444

264,936

44,561

117,561

22,815

95,353

827,372

212,953

309,497

Thousands of Dollars

35,434

15,764

35,000

14,226

45.289

148,745

146,491

272,221

321,263

66.617

106,500

25,639

198,756

115,813

931,068

Source: NOAA. Numbers may not total because of rounding.

The 1983 base is an estimate of 1983 spending. Actual expenditures are higher.

### December Streamflow

The high streamflows of recent months in the West cased somewhat during December, but streamflows increased in much of the eastern United States, setting many record or near record high flows in several states, according to the monthly check on national water resources conditions by the U.S. Geological Survey (USGS).

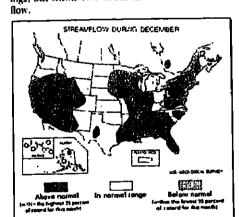
USGS hydrologists said that record or near record high average streamflows for the month were set at 36 stations in 24 states from Georgia to Alaska. In contrast to the many historic high flows, reports of low streamflows were isolated and unusual, with most low flows occurring between the Missisioni River and the Rocky Mountains and in the Pacific Northwest (see map, courtesy

Of the 173 key USGS gaging stations surveyed across the country, 127 (73%) reported streamflows well above average (in the highest 25% of record), 33 stations (19%) reported flows in the normal range, while only 13 nations (7%) were in the lowest 25% of re-

Reflecting the widespread and extremely wet conditions nationwide during December, the combined flow of the nation's three majo rivers—the Mississippi, St. Lawrence, and Co lumbia—was 3937 billion liters per day (bld) (866 billion gallons per day), 68% above the long-term December average, and 6-1% greater than the combined flow in November. These three major rivers provide a useful check on the nation's water resources because they drain more than half of the coterminous United States.

Groundwater levels across the tration tended to be higher in December, largely in response to above normal precipitation. Wells reached record high levels for December in New York, Connecticut, Maryland, Manne, and Nevada. Indicating the variability in the TABLE 1. NOAA Operations, Research, and Facilities Fiscal 1984 Budget, Program Level, in response of groundwater levels to local conditions, single wells in Maine and Nevada also secrecord low levels for the month.

Individual flows of the so-called "Big Five" rivers for December, were as follows: the Mississippi River at Vicksburg, Miss., 2882 bld. 107% above average and 137% more than the flow in November: the St. I awrence River near Massena, N. Y., 777 bld, a decline of 27 from November, but 117 above the monthly average; the Columbia River at The Dalles, Ore., 277 bld, a decline of 28% from November, but 9% above the long-term December average; the Ohio River at Louisville. Ky., 532 bld, or 40% more than the longterm monthly average, and an increase in mean flow of 77% from the previous month: and the Missouri River at Hermann, Mo., 245 bld, 107% above the usual December readings, but down 19% from the November



1,014,777 Reflects congressional deliberations (see Eas, September 13, 1983, p. 548). The conference was

completed October 31 and final approval was granted on November 16. The appropriations bill (H.R. 3222) was signed into law (P.L. 98-166) on November 28.

Although the Reagan proposal includes Coastal Zone Management (CZM) in Ocean and Coastal Programs. Coasial Programs, Congress moved it into a separate account outside of ORF. The final conference ORF total does not include CZM.

# **Coastal Mining**

The Exclusive Economic Zone (EEZ) declared by President Reagan in March 1983 has met with a mixed response from those who would benefit from a guaranteed, 200nautical-mile (870-km) protected underwater mining zone off the coasts of the United States and its possessions. On the one hand, the U.S. Department of the Interior is looking ahead and has been very successful in afeguarding important natural resources that will be needed in the coming decades. On the other hand, the mining industry is faced with a depressed metals and mining

market. A report of the Exclusive Economic Zone Symposium held in November 1983 by the U. S. Geological Survey, the Mineral Management Service, and the Bureau of Mines described the mixed response as: "... The Department of Interior . . . raring to go into promotion of deep-seal mining but industrial consortia being very pessimistic about the program, at least for the next 30 or so years." Chemical & Engineering News, February 5,

The circumstances are not too different from those surrounding U.S,-sponsored ocean margin drilling programs. The govern-

ment would like to spend the required effort lwork for future decnow to lay the ground dustry sees at least ades. The petroleum industry sees at least or 2 decades of relatively cheap continental petroleum sources being available and would like to delay the huge costs of continental margin exploration.

Right now there are few if any confirmed

omic mineral deposits within the EEZ. There are copper ores that are not being mined due to the depressed internation market. Indeed, copper prices have not risen in almost 2 decades. The new extended zones will experience little actual mining activity until they are explored and evaluated. A serious factor in their development will be environ-mental protection. Lacking the costs of satisfactory environmental constraints, foreignproduced metals are proving to be much cheaper in the United States than domestically produced metals. Exploration, evaluation. and a working minerals policy will be key is-sues in the development future of EEZ ore deposits, but costly research and exploration in high-risk zones is not a high priority for U.S. mining companies because of the eco-nomic realities of world markets.

The EEZ legislation is a United States initiative not unrelated to the decade-long efforts to produce the Law of the Sea. The most important deposits originally envisioned

for the Law of the Sea exploitation were for the most part manganese nodules. The mining of nodules is yet to be realized on a sig-nificant scale, and it may be some time before they can be dredged from the ocean floor economically. The more recent discovery of polymetallic sulfides associated with underwater hot springs has resulted in heightened efforts to protect national resources, and to extend potential mining zones. Whatever U.S. government plans may call for, however, ores requiring expensive mining procedures will not be competitive for the present. It is much more economical to import ores, metals, and indeed, finished products in the current market. The metals market in the United States is characterized, at least in the short term, by Aside from metals, phosphorite deposits lo-

cated within the FEZ may turn out to be the first exploited. A large percentage of mineral sphates are used to make fertilizers, and unlike metals futures, the world demand for phosphates is expected to increase by 70% or more by the end of this century. Thus, there is a good chance that phosphate mining will move offshore by the end of the century. The United States, within the new zones, now has control of sizable deposits.—PMB

## **Geophysicists**

Jeffrey Alt, a student at the University of Miami's Rosenstiel School of Marine and Atmospheric Science, recently was awarded the Koczy Fellowship, given to a doctoral student at the school who has displayed "exemplary scholastic and research ability." His disseration focuses on the mechanisms of submarine hydrothermal systems and on the role that hydrothermal alteration of the oceanic crust

plays in regulating seawater composition.

Kimberlee Miskell, a student in marine goology and geophysics at the Rosenstiel School, has been awarded the 1983 Dean's Prize for the year's oustanding master's thesis. Her thesis is entitled "Accumulation of Opaline Silica in Deep Sea Sediments from the Mid-Cretaceous to the Mincene: a Paleocirculation Indi-

Also at the Rosenstiel School, Alina Stmant Fraction has been appointed a member of the faculty. Next spring she will continue her studies of coral reef energetics and nutrient dynamics at the Hydrolab in the U.S. Virgin

Peter Angus-Leppon, head of the school of surveying at the University of New South Wales in Sydney, Australia, has been awarded a senior scientist grant by the U.S. National Academy of Sciences' National Research Conneil. The grant will enable him to under take geodesy research with the U.S. National Geoderic Survey, Angus-Leppan also was recently elected president of the International Association of Georlesy for 1983–1987.

Anton L. Inderbitzen is the new associate chief scientist of the Poka Science Division, Division of Polar Programs, in the National Science Foundation.

#### Recent Ph.D.'s

Last remoderally lists inframination on free fills at reprof doctoral dissertations in the disciplines of geophysics. Faculty no informatic invited to submit the following information, on aismotion lenerhead. above the signature of the faculty advisor or department chamman.

O) the dissertation ride.

(2) author's name. (3) name of the degree-graning department and

(1) month and year degree was awarded

If possible include the current address and telephone number of the degree respects (this infor-mation will not be published) Many dissertations, including those with order numbers, are available from Lawersity Microphins

International, Dissertation Copies, P.O. Box 1764. Ann Arbor, MI 48106 Applications of Hydrologic Modeling to Water Re-

source Assessment (Connecticut), Michael J. Brown, Harvard Univ., 1983 (GAN83-

Biogeochemistry of Manganese and Iron in the Paohe Ocean, William M. Landing, Chemistry Dept., Univ. of California at Santa Cruz.

Causation and Variability of the Northern Winter Quasi-Stationary Planetary Waves, David A. Jacquiin, Harvard Univ., 1983 (GAX83-22377).

Clear Atmospheric Effects on Insolution Illustrated by Broad-Bund Radiometer Measurements (Washington, Mt. St. Helenst, Daniel W. Spencer, State Univ. of New York, Albany.

1983 (GAX83-22620). Depositional and Diagenetic Environments of Car-bonute-Siliciclastic Rocks of the Glen Dean Formatton (Upper Mississippian), Illinon Basin, U.S.A., Sadat Feizmia, Univ. of Illinois, Urbana-Champaign, 1983 (GAX83-24547).

Effect of Asymmetric Ehman Dissipation on Fmite-Amplitude Baroclinic Disturbance, Shih-Hung Chou, Dept. of Atmospheric Science, State Univ. of New York at Albany, December

Generation and Characterization of Particulate Aerosols From Virgin Carbon Fibers and Comsas, 1983 (GAX83-22962).

Interpretation of the Aeromagnetic Data Covering Portion of the Damara Orogenic Belt, With Special Reference to the Occurrence of Uramferod Granite, Branko Corner, Univ. of Witwatersrand (South Africa), 1983.

Migration of Reflection Seisme Data in Angle-Midpoint Coordinates, Richard A. Ottolini. Stanford Univ., 1983 (GAX83-20760). Moisture and Heat Transport, and Ocean Gooling Along the Truck of a Moving Storm, Sami F. Al-Fahed, Catholic Univ. of America, 1983

(GAX83~24404). Numerical Investigation of the Formation of Secondary Vortices in Laboratory Simulated Tornadees, Robert L. Walko, Univ. of Arizona,

1983 (GAX89-24466). -Paleomagnetism, Rock Mugnetism and Diagenesis

in Hemipelagic Sediments From the NE Pacific Ocean and the Gulf of California, Robert Karlin, Dept. of Geophysics, Oregon State Univ., November 1983. Temperature and Axial Strain Rate Effects on Mi-

cromechanical Behavior in Triaxially Compressed Marbles, Joseph K. Schrodt, Univ. of iois, Urbana-Champaign, 1983 (GAX83-24638).

17

# The VGP News



February Brook Box, 11721 Day River Court, Review, VA 22004 (telephone 704 860 3470, after 5:30

## A Relation Among Geomagnetic Reversals, Seafloor Spreading Rate, Paleoclimate, and **Black Shales**

Eur R. Force

The Mesozoic Cenozoic histories of reversals in the earth's magnetic field and of periode of widespread arroxia in the exemplasins show a remarkable correlation (Figure 1); periody of black shale deposition Canoxic events") occur during lengthy periods without magneto, reversils Cquiet" periods). My assembly of published work indicates a remore connection between quiet periods and anoxic events and surgests its form: Magnetic quiet periods coincide with fast seaffoor spreading. During these periods, buoyant spreading rulges displace seawater onto broad shelves, thus decreasing earth's albedo and causing global warning. Temperature gradients, and thus densits gradients, from pole to equator decrease in surface waters, and the deep ocean currents of oxygenated polar waters wane. Oxygen minimum zones intensity and widen; anoxic conditions throughout entire basins are indicated by black shales deposited in the deep sea. These relations thus suggest that the earth's interior processes and its dimate are related and their status recorded by both magnetic polarity and anosic event chronologies of the earth. A test of the model for the Palezoic is proposed and some implications for mineral resources int-

Mendan et al. [1982] noted an empirical link, based on both the Jurassic and Cretaceous quiet zones, between fast seafloor spreading and stable magnetic polarity. They suggested that erupting heat plumes couple activity of the outer core and lower mambe. The relationship between imagnetic polarity and spreading rate is seen at several spreading centers (Figure 1)

The link between fast spreading and transgression is well established [Have and Pilman, 1973] Because newly generated oceanic crust couls and subsides as a function of time regardless of spreading rate, fast-spreading cemers have a broad cross section (Figure 2) An more see in spreading rate thus displaces seawater onto continental shelves and into epiconimental seasons. Cretareous high sea esels observed in wations on riatons correspoud to times of last spreading (Hast and Parson, 1973, Violet al., 1977).

Cakedanous of the earth's albedo in the Orthogons (with continents in their correct positions for the time, show that high sea levele and consequent larger occans resulted in a significant albedo decrease (Barron et al., 1980) More solar energy was absorbed. However, committee of the magnitude of warming are not yet provible because feedback factors ofte per e lemejances see, longly mingelettorif. Greater atmospheric CO2 contents due to ins reased soleanium during times of last spreading (Berner et al., 1983) reinforced this ellert Warmer paleochmates have long been observed from fossil assemblages and oxygenisotope measurements (Figure 1) for roughly the Apisan to Campanian (mid-late Creta-ceous) and the Middle to Late Jurassic [Doug-Las and Secret, 1975; Frakes, 1979; Saven, 1977;

lierdon, 1974] A percase in the surface temperature gradeens from pole to equator is also observed by these authors from these time periods, i.e., the temperature increase near the pole was greater than that near the equator. These

gradients are lower during warm periods because polar ice cups with high albedos retreat and because poleward transport of the latent heat of evaporated water increases [Manabe and Wetherald, 1980; Kellogg, 1979].

A link between low temperature gradients and occan stagnation was proposed [Schlanger and Jenkym, 1976; Fischer and Arthur, 1977] partly because of coincident timing of widespread black-shale deposition (anoxic events) and periods of equable climate. Compare the situation today with that in the Cretaceous; today's high temperature gradients (and ome generation of saline waters by incongru ent freezing) cause high density gradients in seawater and drive vigorous bottom currents from the poles. These currents today prevent significant ocean stratification; ocean-wide zones of strong oxygen-minima form only where bottom currents are weak e.g., the north Pacific [Demaisson and Moore, 1980]. In the Jurassic and Gretaceous, low temperature gradients must have resulted in weaker bottom currents (though probably not in weaker surface and atmospheric circulation [Barron and Washington, 1982]). Bottom waters may have been generated in sub-tropical evaporative basins [Thierstein and Berger, 1979]. imun zones became widespread. Intersections of oxygen-minimum zones with ocean floors are the sites of black shales penetrated in Deep Sea Drilling Project (DSDP) holes and sections now on land (Fig-ure 2); locally, black shales formed in silled busins also [*Thurstein and Berger*, 1979]. The timing of black-shale deposition is shown as anoxic periods on Figure 1. Periods of widesprad anoxia are of eco-

nomic importance because the organic pre-cursors of petroleum were preserved in sedi-ments [Arthur and Schlanger, 1979]. These perieds also saw formation or preservation of some metal deposits (Cannon and Force, 1983; Force et al., 1983], due to strong solubility contrasts between anoxic and oxygenated water. For example, massive polymetallic sulfides that formed on ocean floors during anoxic periods have probably been selectively steserved (Figure 2).

Other authors have assembled some of the same links to form other models [e.g., Keth, 1982]. The models most similar to the one in this paper is Fischer [1981] and Sheridan

Genetically related events should be similark spaced in time, and this spacing has not been shown yet across the spectrum of link-ages proposed here. Mesozoic changes of spreading rate are presently documented only over time periods of about 10~30 m.y., whereas anoxic periods and their associated sea level fluctuations (third-order fluctuations of Vail et al. [1977]) occupy 3-10 m.y. (Figure 1). Currently available spreading-rate histories for the Mesozoic are very crude, how-ever. In order to see whether hidden changes in spreading rate could plausibly result in ob-served 3–10 m.y. fluctuations, I calculated 'backward" to determine a spreading-rate increase which could result in a sea level rise of 100 m in 5 m.y. Present total length of ridges (58,750 km), cylindrical ocean basins, and present areas of oceans and of land areas 0-100 m in elevation were assumed. The increase required is about 2.1 cm per year half rate for all ridges, or about 12-70% of observed average spreading rates for ridges listed by Hass and Pitman [1973] for the Cretaceous magnetic quiet interval. This rate seems possible, and therefore changes in spreading rate might indeed cause 3-10 m.y. sea-level fluctuations. The question of regression rate was not addressed. Schlunger et al. [1981] record midplate seafloor volcanism and raised seafloors from the Cretaceous; these factors (and ridge proliferation) are probably related to spreading rate changes, and potentially lessen the magnitude of increased spreading

rate needed to produce transgression With oriented DSDP cores, testing of this hypothesis by resolving the sequence of events within single cores should be possible. am conditions should a precede magnetically quiet intervals (unless the model is backwards?)

It this hypothesis has genetic significance, it should hold regardless of when the specified conditions occurred. Periods of widespread anoxia have been proposed for the Paleo from black shale sections on land alone because no intact ocean floor remains [e.g., laggen, 1980]; these sections should not contain nagnetic reversals in those portions showing

carbon-isotope retords of open-ocean anoxia Numerous other tests of the model would see how well one factor predicts another; if results are positive, some of these tests could develop into mineral exploration techniques (for example, a link between magnetic polari ty and some sedimentary minerals).

Many of the linkages proposed here are matters of dispute or incomplete work, so errors in my depiction are likely. Nevertheless, the accord with observed features of earth history across the entire spectrum of linkages, and the similarity of the "signals" recorded by magnetic reversals and anoxic periods are in-dications that the general form of the hypothesis is correct. If so, a connection exists between processes in the earth's interior

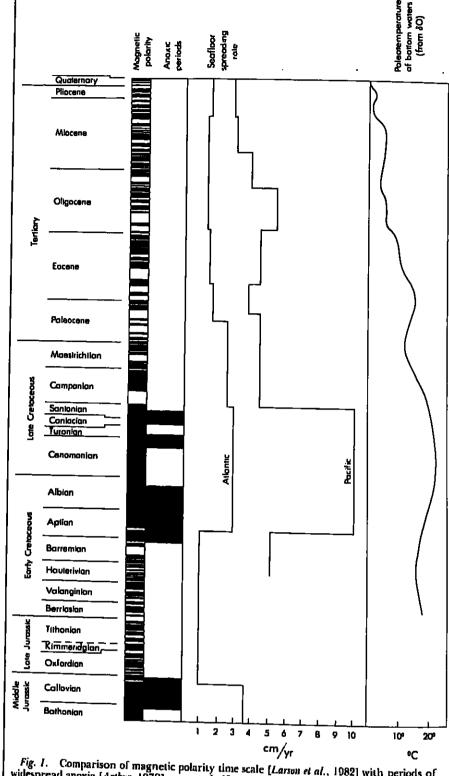


Fig. 1. Comparison of magnetic polarity time scale [Larson et al., 1982] with periods of widespread anoxia [Arthur, 1979], average half-rates of sea floor spreading (simplified from Larson and Pitman [1972]; and Sheridan et al., [1982]) and oxygen isotope-derived bottom paleotemperatures from the north Pacific [Douglas and Savin, 1975]. The presence of all the chronologies in a single data set (cores of the DSDP), minimizes systematic offsets, but detailed correlation is still a problem.

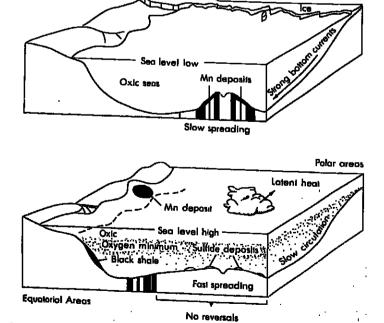


Fig. 2. Cartoon contrasting (lap) state of rapid magnetic reversals, slow spreading, low sea level, cold high-gradient climate and oxic oceans (icehouse state of Fischer [1981]) and (bollom) state of magnetic quiet, fast spreading, high sea level, warm low-gradient climate and dysaerobic oceans (greenhouse state). Degree of oxygen depletion proportional to stippling: oxygen minimum zones would intersect only seamounts, plateaus, and basin margins in the deeper Pacific.

which produce its magnetic field and climatic References. response at its surface.

I am indebted to W. F. Cannon, R. P. Sheldon, Louis Nicolaysen and others for discussions on the form of linkages and to L. W. Snee and Lisa M. Pratt for help in formulat ing the Palezoic test. Suggestions by participanis in the 1985 Penrose conference "Cretaceous Climates" are appreciated.

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Cover. Geological formation known as the Great Dike of Rhodesia extends from upper center to lower left in this photo-graph taken from space shuttle Challenger ighth shuttle mission, September 1983. Because of the shuttle's nighttime launch, the crew was able to photograph during daylight parts of Africa, the Amazon jun gle, and the Australian desert that previous crews had seen only at night. (Photo courtesy of NASA.)

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Eric R. Force is with the U.S. Geological Survey, Resion, VA 22092.

# Meetings

# Water in Silicate Melts

Water is one of the more important volatile

species in magmas, both in terms of its abun

dance and its influence on the properties of a given magma. Many workers in the geological sciences have measured, modeled, and speculated on the interaction of water with silicate melts as a function of pressure. At the same time, glass and materials scientists have col-lected a considerable body of data on the effect of water on the properties of liquid and glassy silicates at 1 amosphere (1.01325 x 103 N m<sup>2</sup>) and below. A special session on "Solubility and Transport Properties of Water in Silicate Melts" was held during the 1983
AGU Spring Meeting, May 80—June 3, in
Baltimore. The session had three main objectives: (1) review the present data base and discuss the status of current models in order to identify areas where further work is needed; (2) introduce interested geologists to the large body of work being carried out in the glass and materials sciences; and (3) consider static properties, such as thermodynamic rela-tions, structure of hydrous melts, and dynamtions, structure or nyurous mens, and dynamic le properties including diffusion and viscosity. This report summarizes the major topics dis-cussed, wore detailed information may be found in the published abstracts (Ess., May 3, 1983, pp. 338-543). The session opened with two papers setting

the geological perspective of water solubility in magmas. J. Eichelberger and H. Westrich discussed the observed water content and distribution in obsidian flows, where the average observed water content reflects the solubility of water in rhyolite liquid at near 1 atmosphere pressure. They considered the effect of degassing on water distribution within observed flows, and on the water content of ejected material during explosive eruption. J. Clemens reviewed measured and estimated contents of water for a variety of andesitic to granitic rocks. He found melt-water contents etween 0.7 and 7 wt % water depending on the sample and source conditions (but with a general average value near 3 wt %), and he discussed the relative merits of methods for estimating water content. J. P. Coutures and G. Urbain presented a survey of solubility repults obtained by glass and materials scientists for silicate glasses and liquids near 1 atmo-sphere. These water solubilities generally fall around 0.05-0.2 wt %, with some possible systematics as a function of composition. Discrepancies between different data sets, however, preclude any detailed correlations at

P. McMillan and J. Holloway summarized some water solubility measurements on synthetic and natural silicate melts at high pressures. Again, some systematic behavior with composition was noted, but the present data base is too limited to explore this fully. F. Stolper, L. Silver, and R. Aines summarized their recent infrared spectroscopic work on the speciation of water in hydrous silicate glasses and presented the results of new studics at high temperature. They found that both hydroxyl and molecular water species coexist to at least 550°C, supporting their dissolution model for water in molten silicates.

The next two papers concerned modeling of thermodynamic relations for hydrous melts. D. Eggler considered the dissolution reaction of water in diopside melt, and discussed Henrian, Henrian analogue (a =  $x^2$ ), and non-Henrian expressions for its activitycomposition relations. A. Boettcher presented experimentally determined melting curves in the systems NaAlSiaOa-HaO-COv and SiOa-H<sub>2</sub>O-CO<sub>2</sub>. He compared and contrasted mixing relations in the fluids and silicate liquids for these two systems. These data suggested that CO2 is soluble in SiO2 liquids at high pressures (greater than or equal to 15 kbar) nd high water contents. Discussion which followed this general topic emphasized that useful thermodynamic descriptions for such hydrous systems need not be simply correlated with structural changes in the melt.

Four papers examined the dillusion of water in hydrous glasses and melts and the effect of water on diffusion of other species. M. Tomozawa described the importance of water in the glass sciences and then presented the results of several studies of water diffusion in silicate glasses. One interesting result was the large observed dependency of the diffusion coefficient on the stress regime in nonhydrostatic experiments at relatively low pressure

Two papers by K. Lapham and J. Karsten reviewed water diffusion studies in silicate melis and glasses and presented some results

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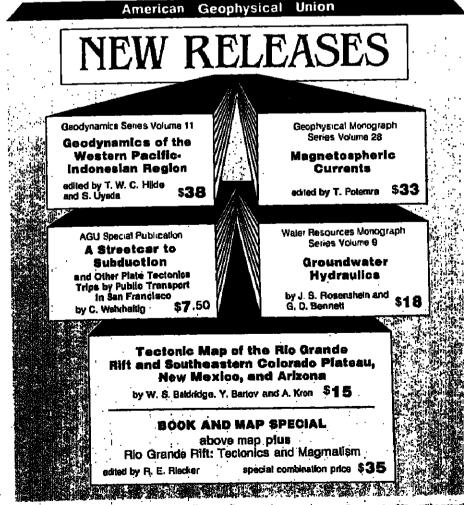
of their recent studies on diffusion of water in obsidian. Observed variations in the diffusion coefficient with temperature and compo sition were summarized and current models for the "water" diffusion mechanism were discussed. Laphon noted no pressure depen-dence of the diffusion coefficient in her obsidian study, in contrast to that observed by M. Tomozawa. This difference may be partly due to the higher pressures and temperatures involved in the obsidian runs and perhaps the hydrostatic nature of these latter experi-

T. M. Harrison and E. B. Watson discussed the effect of water content on the diffusion of zirconium in granitic melts. They found a large increase in diffusivity and solubility at higher water contents and discussed the effect of this on ziron dissolution kinetics in hydrous granitic magmas.

The afternoon poster session included a number of presentations directly related to the discussions in the morning.

From informal discussions before, during, and after the meeting, we teel that the following general combusions may be drawn. First, there are relatively few published estimates for water contents of primary igneous magmas, and more solubility data are necessary for synthetic and natural compositions at both high and low pressures. Lakewise, dillusion data as a function of pressure, temperature, and composition are want. Evidently more experiments are needed. Second, empirical modeling of thermodynamic and dynamic properties is a useful and necessary field, especially for those interested mainly in calculation of the effect of water on bulkproperties. At the same time, mechanistic studies at the molecular level will lead to a better understanding of water-melt interactions at the microscopic level. More spectroscopic studies are needed on hydrous glasses. and especially on hydrous melis at pressure and temperature. We teel that both empirical modeling and structural studies are worthwhile and should be pursued with as much interplay between the two approaches as pos-

This meeting report was prepared by Paul Mc-Millan, who is with the Department of Chemistry, Arizona State University, Tempe, AZ 85287 and Edward Stolper, who is with the Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA 91109.



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#### Geophysics in the Affairs of Man: A Personalized History of Exploration Geophysics and its Allied Sciences of Seismology and Oceanography

G. C. Bates, T. F. Gaskell, and R. B. Rice, Permagon, Oxford, xx + 492 pp., 1982, \$25.

Reviewed by Carl Kindinger

This book traces the developments of the applications of the geophysical sciences to a sariety of societal needs from misty beginnings to now, with emphasis on the "golden age," the early 1920's through the 1960's. The phrase "applied geophysics" is so often taken as symmenous with "geophysical exploration" that the broader viewpoint of this sork is especially welcome. The authors certainly devoted much of their treatment to exploration geophysics, as is appropriate in view of the large commitment of human and financial resonres to this endeavor and the practical importance of the results. However, they have also included interesting skewher of military applications of geophysical techinques and the important technological advalues that have come from these, as well as mach material on ocean science. Atmospheric and space science receives less detailed cover-

The opening chapter, historical back-ground to the developments of the 20th cen-turs, is brief, incomplete, and uneven in its coverage. An adequate treatment could wellhave doubled the size of the book, but some fundmark developments that I booked for are missing. The hearr of the book is the decadeby decade story of each of the major themes (exploration, occur service, global seismology) from the end of World War I through the Paidys. The story is told in terms of the personalities who built the subjects and the sents that shaped then progress It was him to read this revew and interpretation of one's teachers and friends. This is a humanized history of the grand projects that have moved geophysics ahead, the key technical developments along the way and the interplay of the creative minds responsible for progress.

The origins of science exploration for oil are explored, with emphasis on developments in the United States, but with a fair treatment. of European contributions. Gravity and magnets methods are treated in less detail. The

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parallel growth of carthquake seismology and oceanography in the 1930's is presented in terms of the leaders who emerged and the institutions that nurround the efforts.

The enormous impact of World War II on technical and theoretical developments important to geophysics follows. The progress in all areas in the postwar period is highlight ed by the story of Project Vela-Uniform, the search for methods to monitor underground nuclear tests that jerked seismology into the modern era within a few years, beginning in 1959. The continuation of this effort to the present is a theme through the rest of the book. Progress and the new leadership that emerged in the 1970's and 1980's are not treated in any detail. The commercial aspects of exploration geophysics, a big business in-deed, are also explored in a personalized way through the stories of a number of the companies, large and small.

The tale rambles a bit along the way and the authors get immersed in great detail in places where they are talking about topics with which they have been closely associated. As a reader who cannot ignore a footnoie. I found the flow of the text interrupted continuously by the need to drop to the bottom of the page for the ancillary information offered. I was amused by the penchant for military titles used throughout (Rear Admiral Hoyd Berkner, USNR; Lieutenant "Jimmy" Carter, USN (Retired)).

I liked very much the personal evaluations by a number of well-known geophysicists of their own achievements and experiences. The book closes with this section, which should help remind today's students that the advaricement of science, including triumphs and blunders, results from the efforts of peo-

ple very much like themselves. The authors have some strong prejudices that come through clearly in places. They don't like "environmentalists" and they take a dim view of a variety of national social programs of the recent past, including affirmative action in its various forms. I think that the kind of sucastic assault on the environmentalist movement in the first part of chapter 7 has an effect similar to that of James Watt: The true believers perceive the need to circle the wagons more closely and dig in deeper. The authors do mention some of the ourstanding women and minority-group members who have been leaders in the fields owered, but the fact remains that the numher of such people is very small. I think that as a history of applied geophysics, the book would have been better without these elements, but here my own prejudices are show-

Texas A&M University/Geological Oceanography Positions. The Ocean Drilling Project (ODP) insisted application for the following anticipated positions Several full-time staff scientists (Ph.D. required). These openings, in various fields of marine geocrence, are anticipated to be filled over a one year period commencing 1 October 1983. The successful candidates will be expected to participate approximately two months per year aboard a scientific drillship. These individuals will be responsible for coordinating activities prior and subsequent to the cruises, including the publication of results. The successful candidates will be expected to attend the JOIDES panel meetings relating to their scientific expertise. Several full-time marine technicians. Previous shiphoral experience and undergraduate degree in geology or related science highly desirable. These positions require participation of about 6 munits oil) aboard a scientific drillship charter. Applicants should submit a letter of application, curriculum vitae and natures of 3 references to: Dr. Philip L. Rabinowitz, Project Director, ODP, Dept. of Oceanography, Texas A&M University, College Station, TS, 77843.

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The book is a useful source of background on people and events that stimulated the growth of important parts of the geophysical sciences. It is especially important because it reminds us of the long-term effects on whole areas of human endeavor of isolated and apparently unrelated events.

Carl Kisslinger is with the Cooperative Institute or Research in the Environmental Sciences at the University of Colorado, Boulder, CO 80309.

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Assessment Committee, Board on Atmospheric Sciences and Climate, Commission on Physical Sciences, Mathematics, and Resources, National Research Council, National Academy Press, Washington, D. C., 1983,

rmation Measurements, I. Joo and A. Detrekoi (Eds.), Akademiai Koado, Budapest, xxii + 900 pp., 1983, \$59.

Earthquakes, Tides, Unidentifed Sounds, and Related Phenomena: A Catalog of Geophysical Anomalies. Compiled by W. R. Corliss, The Source Book Project, Glen Arm, Md., 1983, \$12.95.

Earthquakes, Volcanoes, and Tsunamis: An Anatomy of Hazands, K. V. Steinbrugge (Ed.), Skandia Corp., xv + 392 pp., 1982, \$35. Eddies in Marine Science, A. R. Robinson (Ed.), Springer-Verlag, New York, xxv + 609 pp., 1983, \$45.

bria, Nonequilibria, and Natural Waters, 2 vols., R. M. Pytkowicz (Ed.), John Wiley, New York; vol. 1, xv + 351 pp.; vol. 2, xv + 353 pp.: 1983, \$49.95 each. Groundwater Bibliography, F. van der Leeden, Geraghty & Miller, Syosset, New York, viii

+ 400 pp. 1983, \$16. Hydraulic Fracturing and Geothermal Energy, S. Nemat-Nasser, H. Abe, S. Hivakawa (Eds.), Martinus Nijhoff, Boston, xi + 528 pp., 1983. \$78.50.

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Committee on Dam Safety, Washington, D. C., 1983.

The International Field Year for the Great Lakes, E. J. Aubert and T. L. Richards (Eds.), National Oceanic and Atmospheric Administration, Ann Arbor, xi + 410 pp., 1983. It Began with a Stone: A History of Geology From the Stone Age to the Age of Plate Tectonics, H. Faul and C. Faul (Eds.), John Wiley, New

York, xvii + 270 pp., 1983, \$38.95. Kinetics and Equilibrium in Alineral Reactions, S. K. Saxena (Ed.), Springer-Verlag, New

York, x + 273 pp., 1983, \$39.80. The Major Biogeochemical Cycles and Their Interactions, B. Bolin and R. B. Cook (Eds.), John Wiley, New York, xxi + 532 pp., 1983, \$74,95.

Man, A Geomorphological AgentAn Introduction to Anthropic Geomorphology, D. Ash-boren (Ed.), D. Riedel, Boston, xii + 165 pp., 1983, \$45.50.

Metal Pollution in the Aquatic Environment, U. Forstner and G. T. W. Witman (Eds.), Springer-Verlag, New York, 1983, \$29.

The Phanerozoic Geology of the World, M. Moullade and A. E. M. Nairn (Eds.), Elsevier,

New York, x + 450 pp., 1983, \$12.75. The Physics and Chemistry of Color: The Fifteen Causes of Color, John Wiley, New York, xx + 454 pp., 1983, \$43.95.

Practical Sedimentology, D. W. Lewis, Hutchinson Ross, Stroudsburg, Pa., ix + 229 pp.,

Principles of Aquatic Chemistry, F. M. M. Morel,

John Wiley, New York, ix + 446 pp., 1983, \$49.95. ocial Science Research and Climate Change: An Interdisciplinary Appraisal, R. S. Chen, E. Roulding, S. H. Schneider (Eds.), D. Rie-

del, Boston, viii + 255 pp., 1983, \$43.50. Solar-Terrestrial Physics: Principles and Theoretical Foundations, R. L. Carovillano and J. M. Forbes (Eds.), D. Reidel, Boston, xvii + 858 pp., 1983, \$155.

Statistical Methods in Geology for Field and Lab Decisions, R. F. Cheeney, George Allen & Unwin, Boston, xvi + 169 pp., 1983, \$25. Terrigenous Clastic Depositional Systems: Applica-tions to Petroleum, Coul, and Uranium Explonation, W. E. Galloway and D. K. Hobday (Eds.), Springer-Verlag, New York, xv + 423 pp., 1983, \$39,

The Thunderstorm in Human Affairs, E. Kessler (Ed.), University of Oklahoma Press, Norman, 1983, \$24,95.

Topics in Ocean Physics, Proceedings of the International School of Physics "Enrico Fermi," Course 80. Italian Physical Society, A. R. Osborne and P. M. Rizzoli (Eds.), North-Holland, New York, xv + 550 pp., 1982,

Oceanography/FSU. Assistant Professor in Marine Chemistry or Biogeochemistry, Chemistal Sedinentology or Atmospheric Geochemistry. Applications invited for position starting with 1984–85 academic year. Contact by I March 1984: Chemical Oceanography Search Committee, Department of Oceanography, Florida State University, Talkhassee, FL 32306, Telephone: 904-644-6705, We are an equal opportunity employer.

Computer Programming and Research Support.
Science Systems and Applications, Inc. (SSAI) is seeking responsible applications oriented Scientists/
Programmens/Engineers to provide systems software and hardware support services. Applicants must have BS/MSPhD degrec(s) amd demonstrated experience in scientific programming (FORTRAN) and results analysis with large scale numerical simulations on mainframe (IBM) and supermini (Digital VAX) computers. These positions are located in metropolitan Washington, D.C. area. The projects areas involve satellite remote sensing, meteorology, agroclimatic environmental/monitoring and research in atmospheric sciences and gentlysics. The posi-

areas involve salellite remote sensing, meteorology, agroclimatic environmental/monitoring and research in atmospheric sciences and geophysics. The positions vary from junior programmer, senior analyst/programmer to senior research scienists(s). SSAI provides a congenial academic work environment, pays bonuses and provides competitive salaries. Send your resume with salary history and references to: SCIENCE SYSTEMS AND APPLICATIONS. INC. 10910 Greenball Page Stite 440

TIONS, INC., 10210 Greenbelt Road, Suite 640, Seabrook, MD 20706.

Geophysica/Oregon State University. Applications are invited for a 12-month, tenure track position for an Assistant or Associate Professor of Geophysics in the College of Oceanography to complement the present eight member Geophysics faculty. The applicant must have a Ph.D. or equivalent, a demonstrated ability to conduct independent research in theoretical or observational geophysics, and to obtain research funding. Applicants will be considered in most areas of solid earth geophysics. Duties include teaching graduate courses in geophysics, supervising graduate students, and developing a program of grant-funded research. Interested candidates should submit a resume, names of three references, and a brief statement of research plans by March 1, 1984, to: G. Ross Heath, Dean, College of Oceanography, Oregon State University, Corvallis, Oregon 97351.

Oregon State University, an affirmative action/equal opportunity employer, complies with section.

equal opportunity employer, complies with section 540 of the Rehabilitation Act of 1973.

University of Arkanass/Tenure-Track Position— Structural Geology. Applications are invited for a tenure-track position in structural geology/tectonics, beginning August, 1984. The Ph.D. is required. Candidates who will strengthen our anticipated Ph.D. program with research interests in field-ori-ented studies of rock deformation, rock fabrics (or metamorphism), or the tectonics of active marging which would complement growing programs in geometamorphism), or the tectonics of active margins which would complement growing programs in geophysics, sedimentation, and petrology are encouraged to apply. The successful applicant will direct graduate research and maintain this program with outside funding as well as teach undergraduate and graduate courses in structural geology and tectonics, an occasional course in introductory geology, and provide some support for the Montana field camp. Rank and salary are open, depending upon experience and qualifications. Applicants should submit a resume and statement of teaching and research interests directly and arrange to have at least 3 leuers of recommendation sent to Robert C. Morris, Department of Geology, University of Arkansas, fayof recommendation sent to Robert C. Morris, De-partment of Geology, University of Arkansas, Fay-etteville, AR 72701. Phone 501-575-3355, Deadline for all material is March 81, 1984. University of Arkansas is an equal-opportunity/af-

Seismologiat/University of Leeds(UK). The De-partment of Earth Sciences is seeking a Postdoctoral Research Fellow for a two-year period starting April 1984 to help in the continuing study of the seismic-ity and structure of the Cameroon Volcanic Line. The successful candidate will be in charge of the in-stallation and maintenance of a telentectered network stallation and maintenance of a telemetered network (seven stations) and training Cameroon scientists, and will complete the gravity survey of the volcanic province. The project is in full collaboration with IRGM (Cameroon). Applicants should have a Ph.D. in Geophysics, preferably Seismology, and should send their curriculum vitae and three leuers of reference to Professor Briden. University of Leeds, Leeds LS2 9JT (UK) by 8 February. Overseas applicants should initially relex 556473 or telephone 532-431751 ext. 6415.

University of Georgia/12-month tenure-track facul-ty appointment in the School of Forest Resources. Qualifications: Ph.D in hydrology or lorest hyty appointment in the School of Forest Resources. Qualifications: Ph.D in hydrology or forest hydrology with at least one degree in forest resources. Background should include forest resource management and quantitative sciences. Responsibilities: Teach undergraduate and graduate level courses in forest hydrology and watershed management. Develop a research program in an appropriate area of forest hydrology. Rank: Assistant or Associate Professor, commensurate with qualifications. Salary: Commensurate with training and experience. Position available: July, 1984. Applications: All applications must be posiniarked no later than 1 February 1984. Submit resume, transcripts, and names of at least three references to:

Klaus Steinbeck, Chairmat Haus Steinbeck, Chairman
Hydrologist Search Committee
School of Forest Resources
University of Georgia
Athens, GA 30602
Telephone 404-542-1376
The University of Georgia is an Equal Opportuni-

SUNY-Albany/Tenure-Track Position in Tectonics or Structural Geology. The Department of Geo-logical Sciences at the State University of New York logical Sciences at the State University of New York at Albany invites applications for a tenure track position in TECTONICS or STRUCTURAL GEOLOGY starting Fall, 1984. We welcome applicants with interests and experience in tectonic processes, including geophysical and structural approaches; structural geology, including physical properties of earth materials or structural aspects of metamorphic processes; or similar fields which complement our existing strengths. Preference will be given to individuals whose research combines quamitative and field studies. The position will be filled at the Associate or Assistant Professor level. Inquiries or applications should be addressed to Dr. W.D. Means, Department of Geological Sciences, State University of New York at Albany, 1400 Washington Avenue, Albany, New York 12222. Application deadline is February 15, 1984.

ruary 15, 1984.
SUNY-Albany is an equal opportunity/affirmative action employer. Applications from women, minorities, handicapped and Viet Nam era veterans are especially welcome.

Structural Geologist/Geophysicist: University of Wisconsin—Eau Claire. Applications are invited for a probationary faculty (tenure track) position at the rank of assistant professor with salary dependent dent upon experience and training. Preference will be given to applicants with Ph.D.'s showing strong interest in undergraduate teaching and research. Prime responsibilities include teaching structural geology, geophysics, and physical geology and advising students. The appointment begins in late August, 1984.

Applicants should send letters of application, re-umes, university transcripts, and three letters of Paul E. Myers

Faul E. Myers
Department of Geology
University of Wisconsin
Eau Claire, W1 54701
Telephone: 715-836-3732.
Closing date for application is March 15, 1984.
The University of Wisconsin—Eau Claire is an

Summer Assistantships/National Astronomy and Ionosphere Center. NAIC will be conducting a Summer Student Program at the Aredbo Observatory in Puerto Rico. Areas on interest are Aunospheric Science, Planetury Radar Astronomy, Radio Astronomy, Science, The spheric Science, Planeitary Radar Astronomy, Radio Astronomy, Electronics and Computer Science. The assistantial pair are normally for ten weeks with the starting date being flexible. Graduate students and undergraduates who have completed at least three, years of undergraduate training as of next summer are eligible. Travel coast to and from Puerlo Rico will be paid by NAIC. Application forms, which must be submitted by February 1, 1984, are available from the Office of the Director, NAIC, Spaca Sciences Building, Cornell University, Ithaca, New York 14853.

University of Oklahoma/Electronics Instrumenta-tion Specialist. The School of Geology and Geo-physics is accepting applications for a full-time Elec-tronics Instrumentation Specialist. Principal respon-sibilities will include maintenance, calibration and sibilities will include maintenance, calibration and user instruction for a new, computer-automated Rigaku XRD-XRF system, and maintenance and repair of electronic components of other lab facilities in the School, Additional opportunities could include involvement in the University's electron microscopy lab (SEM and TEM), and the development of a Van de Graaf-PIXE analytical system in collaboration with O.U. physicists. Applicants should have a B.S. in Geology, Chemistry, or Electrical Engineering or equivalent in experience; salary is commensurate with qualifications. Send curriculum vitae and names and addresses of three professional telerences to:

Dr. David London

School of Geology & Geophysics

University of Oklahoma

Norman, Oklahoma 73019

Deadline for applications is March 16, 1984.

The University of Oklahoma is an athronalive accordence (apportunity enrolleer) equal opportunity employer.

Applied Geophysics/Bolling Green State
University. The Department of Geology invites application for a tempre track, assistant professor position in Applied Geophysics to begin September 1984. Ph.D. required. The successful candidate will be expected to develop a research program in some aspect of Applied Geophysics and teach courses in Geophysics, Exploration Geophysics and in his or her specialty.

Geophysics, Exploration Geophysics and in his or her specialty.

The Department has eleven fulltime faculties. In addition, two faculties from the Physics Department participate in our geophysics program. Complete geophysical instrumentation, including a seismograph station and rock mechanics lab, is available.

Interested persons should send resume, statement of research interests, official transcripts, and three letters of reference to: Charles M. Onasch, Chairman, Search Committee, Department of Geology, Bolling Green State University, Bolling Green, OH 43403.

The closing date is March 15, 1984. BGSU is an equal opportunity/affirmative action

University of Washington/Geophysics—Research Paculty Positions. Applications are invited for two or three openings for research faculty, Individuals are to establish innovative and high-quality research programs including stableness. Candidates with interests in the following subfields are particularly encouraged to apply: seismologists with experience and interests in workanic earliquakes and associated phenomena and glaciologists with experience in accap flow modeling or in avalanche mechanics, Send curriculum vitae and four letters of reference prior to 15 March to Professor Rotald T. Metrill, Geophysics Program AK-50, University of Washington, Seatle, WA 98195.

UW is an allimative action/equal opportunity UW is an affirmative action/equal opportunity

Research in Space Plasmas, Solar and Heilospheric Physics. The National Research Council offers Resident Research Associate awards in many areas Resident Research Associate awards in many areas of research; in particular, awards are available at the Jet Propulsion Laboratory in the area of Space Plasma Physics and Solar and Heliospheric Physics, as well as other areas. Areas of research available at JPL include studies of the solar wind, conteary plasma interactions, solar oscillations, magnetospheres of the Earth, Jupiter, and Satorn, plasma waves both in the solar wind and the magnetosphere, and the numerical modeling of apace plassphere, and the numerical modeling of space plas-

as. For further information about research opportu-For further information about research opportu-nities at JPI, in these research areas, please contact any of the individuals listed below: Bruce E. Goldstein (213) 354-7366 Marcia Neugebauer (213) 354-2005 Edward J. Smith (213) 354-2248 Bruce T. Tsurutani (213) 354-7559

Bruce T. Tsurmani (213) 354-7559 All individuals at: Jet Propulsion Laboratory, Mail Stop 169/506, 4800 Oak Grove Drive, Pasadena, CA 91109.

Slop 109-900, and observed the postdoctoral (Regular) level and the Senior Research Associate level. Awards are initially for a period of one year; on some occasions an extension is allowed. Awards to Senior Associates are generally for one year but shorter periods will be considered.

Detailed information on application procedures, all necessary forms, and a list of supporting documents required are available upon request from: Associateship Programs ([H-608-]1) National Research Council 2101 Constitution Avenue, N.W., Washington, D.C.

2101 Constitution Avenue, N.W., Washington, D.C.

Water Resources Engineer/Hydrologisti Faculty Position. A tenure track faculty position at the Assistant or Associate Professor level is available beginning Fall 1984 for a water resources engineer with specialization in hydrology. Applicants must have a Ph.D., and their research interests should encompass pollutant transport phenomena in the compass pollulant transport phenomena groundwater environment. Graduate teaching re-sponsibilities will include courses in both surface and groundwater hydrology. A resume and manes of three references situaled be sent by March 31, 1984 to: Dr. Francis A. Di Committee, Department of Environmental Science and Engineering, School of Public Health 201-H, University of North Carolina, Chapel Hill, NC

27514.
The University of North Carolina is an equal op-

Staff Scientst/PL. Immediate opening exist for Ph.D. In geophysics, planeary science or occanography with minimum four years research experience in planeary geophysics and dynamics. Skould have demonstrated record of accomplishment in independent research and publication. Applicants with interest in structual geology and geophysics as applied to solid-body planets and natural satellites, with emphasis on determining surface properties and processes on planeary objects using ground-base and spacecraft remote sensing data and theoretical and experimental techniques is required. Please submit resume to: Professional Staffung. Dept. L 22, Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasaddna, CA 91109.

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Microprobe Technician-Operator/University of Maine at Orono. Subject to budgetary approval the Department of Geological Sciences at UMO will have this position available by February 1, 1984. Person appointed must be cipable of bringing an automated MAC 4005 probe on line as a routine instrument; also able to instruct students on its operation. Similar capabilities with a mass spectrometer highly desirable. Some geologic background preferred. Initial appointment for one year with likelihood of subsequent reappointment. Sakry in the range of \$17,000-\$20,000/year. Apply to: C.V. Culdotti, Department of Geological Sciences, University of Maine at Orono, Orono, Maine 04-169.

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Center for Ocean-Land-Atmosphere Interactions: Department of Meteorology, University of Maryland, College Park, MD—The Department of Meteorology at the University of Maryland has established a center to study the interactions of ocean, amosphee, and land processes and their impact on dimate variability, and in particular to study the feasibility of dynamical prediction of short-term climate fluctuations. Applications are invited from qualified scientists to join the center at its inception. The center has the following openings:

1. Assulant or Associate Professor. One tenute track position for Orean Modeling. The applicant should have good knowledge of oreanic and atmosphere dynamics, should also have the ability to develop ocean models and carry out research on variability and predictability of short term climate using coupled ocean-atmosphere models.

and predictability of short term climate using complet ocean-atmosphere models.

2. Arotoni or Associate Professor. One tenure track position for Atmospheric Professor. The applicant should have good knowledge of atmospheric dynamics and should have demonstrated his ability to carry out outsanding research on Geophysical Fluid Dynamics. Contributions to the study of atmospheric predictability either using simple models or complex GCMS, would be considered desirable.

3. Research Stientist: One non-tenure faculty position to be supported fully by the grant funds. The applicant should have demonstrated excellent knowledge of atmospheric dynamics and general civilation of the atmosphere. Familian ity with the atmospheric GCMS is desirable but not essential.

4. Assistant Research Scientist: One non-tenure fac-4. Assistant Research Scientist: One non-tenure fac-4. Assumt Keenrin Steinhalt Olive Infliction to be supported fully by the grant funds. The applicant should have demonstrated excellent knowledge of ground hydrology and interaction of vegetation and climate. Familiarity with application of land-surface process models in GCMs is already.

5. Research Associate: One position for one year

5. Research Associate: One position for one year with possibility of extension for the second year. The applicant should be a recent Ph.D. with interest in studying the dynamics of quasi-stationary atmospheric automatics either by analysis of observed data or by analysis of model simulations.

6. Faculty Research Associate: Three positions (two modelling and one for data analysis). The applicants should have at least M.S. in Mercotology and demonstrated their ability to work with large models and high speed computers. They should also have good understanding of synopia and dynamic inetenology, and familiarity with modern techniques of processing large volumes of data.

Letters of application should be sent to.

J. Shukla, Chariman Search Commutee.

Search Connuited Search Commutee
Department of Mercorology
University of Maryland
College Park, MD 207 12
Applications should include a curriculum vitae and names of three references. Applications re-ceived before March 15, 1984 will receive full con-

sideration.

The University of Maryland subscribes to a policy of equal educational and employment opportunity. The University of Maryland, under Title IX of the Foliation Amendment of 1972, does not discriminate on the basis of sex in admission, treatment of

University of Hawail/Marine Geophysics. Hawaii Institute of Geophysics and Department of Geology and Geophysics made applications for existing and amorphed openings in Marine Geophysics. Applicant's specialty may be at the marine applications in any one or more of seismology, geomagnetism, gravity, heat flow, and pliest at vidente-logy. Our choice will be based mainly on the stientist's record of (1) investigations at year of tectonic, agreenes, seelamentary or hydrothermal processes can or below the sea floor, such as at robjectests, treat hes, transform faults, slopes, and seamounts, and (2) abilities and interest to teach in geology and geophysics at introductory as well as at advanced levels. One goistion will be filled at the professor level if a sufficiently qualified scientist applies. Interested persons should send a statement of their research and teaching interests, a resume, a bibliography, and a list of three referres, before 15 February, 1984, to: Dr. Charles E. Helsley, Director, Hawaii Institute of Geophysics, University of Hawaii, 2525 Correa.

Road, Honolulu, H. 19822.

versity of Hawaii is an Equal Opportunity/Atfirmative Action employer and invites applications from, and numinees of, women and members of mi-

Atmospheric Scientist/University of Virginia. Ap-plications for a tenure track assistant professor-ship are sought. We wish to strengthen research capabili-ties dealing with interactions which occur in the liv-dro-biosphere including ditentical transports and transformations. A Ph.D. in meteorology or a close-b related discipline, a commitment to basic re-search, and an interest in working in an interdisci-sioner department are required. Annihations from search, and an interest in working in an increaser-plinary department are required. Applications from women and ethnic minoraties are weborned. A resu-nic, brief statement of research interests and maines of three individuals who may be contacted for refer-ences should be sent to G. M. Hormberger, Chair-man, Department of Environmental Sciences, Clark Hall, University of Virginia, Charlottesville, Virginia agoist

92003.
The University of Virginia is an Equal Opportunity/Affirmative Action Employer.

Geophysics-Tectonophysics/University of Wyo-ming. Applications are invited for a tenure track position at the Assistant Professor level in the De-partment of Geology and Geophysics. Candidates illusted have teaching and research interests in such areas as tectonophysics, thermal modeling and/or plate tectonics. The successful applicant will join an applicable IP II. Jecol prophysics to our am. Duties established Ph.D. level grophysic i program. Duties will include teaching undergraduate and graduate level geophysics courses, and establishing a vigorous research program. Excellent opertunities exist for cooperation with mathematics; the Mathematic Department includes a strong numerical medicules group with interests in geophysics. Send resume, transcripts and duce letters of recommendation by January 15, 1984 to Peter N. Shive, Dept. of Geology/Geophysics, Pt. Box 3006. University of Wysming, Laramic, WY 82071

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Structural Geologist/University of Maryland. The Department of Geology. University of Maryland at Gollege Park, seeks a structural geologist to lift a tentre track position at the Assistant Professor level by August, 1984. The applicant should have a commitment toward quality research and can contribute to a rapidly developing M.S. and Ph.D. program as well as an established undegraduate component. Teaching responsibility mehades structural geology, tectonics, and applied geophysics.

The College Park campus is located in the Washington metropolitan area close to USGS, Cartragic Institute, Smithsonian Institution, Goddard Space Flight Genter, NBS and U.S. Bureau of Mines. For full consideration, applicants possessing Ph.D. should send a curriculum vitac, three letters of reference, and a description of research to: Dr. Roger Nielsen; Scarch Committee Chairman, Department of Geology, University of Maryland, College Park, MD 20741, 301-454-3548.

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TWO SHORT COURSES at

Colorado State University

COMPUTER MODELING FOR WATERSHED HYDROLOGY, June 4-8, 1984, Course Director: J. D. Salas. Fee: \$600.00.

**EROSION AND RIVER BEHAV-**IOR ANALYSIS, June 25-29, 1984. Course Director: H. W. Shen. Fee: \$600.00.

FOR INFORMATION or to receive a brochure describing the courses in detail: Hydrology and Water Resources Program, Engineering Research Center, Colorado State University, Fort Collins, Colorado 80523. (303) 491-8552.

Marine Geologist or Physical Oceanographer: Eckerd College (Florida). Tenure track (Assistant Professor) faculty position to start September, 1984. Ph.D. required Successful candidate will teach in-Ph.D. required. Successful candidate will teach introductory and advanced courses in area of expertise. Applicants with interest in coastal processes and ability to contribute to College general education program will be favored. Establishment of an artice research program is important. Send resume, transcripts, letter of application and three letters of reference before February 28, 1981 to:

Dr. John E. Reynolds, 111
Fekend College.

P.O. Box 125601
St. Petersburg, 11, 33733
Fekend College is an equal opportunity employer.

Middlebury College/Sedimentary Geologist. The Department of Geology weeks a person with skills in sedimentary periodogy, sedimentology, and/or stra-tigraphy, for a tenure track position. Appointment will be, at the entry level and will begin September 1981. Letter of intent, resume, transcripts, and names of three referees should be sont, before March 1, 1981, to Bresster Baldwin, Chairman, De-partment of Goology, Middlebury College, Middlebury, VI 05753

Middlehary, VI 0.5753.

We are seeking an individual who is strongly research-oriented and who can complement the correct petrology-rectiones interests of the department. The undergraduate program stresses held work and research. The our rotuin is desided and will be made companible with the successful randictate's interests. The department has a fully automated element in roprofe, an XR1-XR1 laboratory, and a cessel for studies on Lake Champian.

Middlebury College is an equal opportunity emisloyer.

Geophysicist Position-University of Colorado, Boulder. The Department of Geological Sciences, University of Colorado, Boulder, mynes applications Boulder. The Department of Coological Scenics. University of Colorado, Boulder, investes applications from geophysics's for appearance in to retenine track Loudis position. Applicant, research microsty should be in some aspects of crustal deformation, with emphasis on the use of modern geoslete techniques for the solution of geodernames problems. The successful applicant will have opportunities for collaboration with strong research groups in the Cooperative Insume for Research in Environmental Sciences (CIRES) and the John Insumite for Laboratory Astrophysics (JILA) of the University. This facture member is expected to contribute to the undergraduate and graduate instructional programs by teaching courses in theoretical and/or applied geophysics, as well as assisting in the teaching of courses for non-science majors. The appointer is expected to maintain a vigorous research program, which will include the direction of graduate students in the geophistics program. Applicants must have received a Ph.D. degree and preference will be given to those with one or more years of productive post-doctoral experience. This position will he filled at the assistant professor level. The academic year salary range is \$22,000 to \$30,000.

The desired starting date is September 1, 1984. The application should include a complete curriculum singe, with publication list and reprints of most important publications, and a statement of research to the Search Committee. Apply to: Geophysics Search Committee, Autention: Edith Ellis, Deparament of Geological Sciences, University of Colorado, Campus Boy 250, Boulder, CO 80309.

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#### STUDENT OPPORTUNITIES

Graduate Research Assistantships in Geophysical Michigan Technological University. Fulcomagnetism—Research to determine the time of copper mineralization in the Portage Lake Lava Series using pulcomagnetism. Applicant should have an interest and background in petrology.

Seismology—Macroscismitty study along selected Seismology—Macroeisminty study along selecter segements of the Kewcenaw Rift. Interest in geophysics with background in geology.

Both assistantships: M.S. level, \$5,250/madeink year plus union, variable summer superad.

Camatt: Professor Gordon Frantti, Department of Geology and Geological Engineering, Michigan Technological University, Houghton, MI 49031.

903-487-2531.

oge-nez-2011.

Michigan Technological University is an equal op-ortunity cducational institution/equal opportunity

SERVICES, SUPPLIES, COURSES, AND ANNOUNCEMENTS

AND ANNOUNCEMENTS

Scanning Electron Microscopy and X-ray Microanalysis/Lehigh University. June 11–15, 1984.

The course will cover fundamentals of 5kM and electron microprole, energy and wavelength dispersive X-ray detectors, qualitative and quantuative X-ray analysis, preparation of biological sparimens, and an introduction to stanning transmission electron microscopy. The lecture material will be complemented by seven laboratory sessions. Five 5EM instruments, one automated electron microprobe and one STEM instrument will be available in the laboratories. The course is open to engineers, technical managers, and advanced technicians in the fields of biology, geology, and materials science.

Fee: \$750. Comitant Professor J.I. Goldstein. Department of Metallurgy and Materials Engineering, Lehigh University, Whitaker Lah #5. Bethlehem, PA 18013, telephone 215-861-4221 for detailed course brochure and registration form.

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University of Colorado-Boulder—Tenure Track
Position in Atmospheric Dynamics. The Department of Astrophysical, Planetary and Atmospheric Sciences (formerly Astro-Geophysics) Invites applications for a tenure track faculty position in the field of utmospheric stience. The successful applicant must have a Ph.D. degree and should possess a strong background in geophysical fluid dynamics or dynamic meteorology, preferably in modeling large-scale terrestrial and/or planetary circulations. The appointment will be at the assistant professor level (although the associate professor level is not ruled out) and will begin August 29, 1984.

Applicants should have a strong commitment to research and to leaching at the graduate and undergraduate level. The opportunity will exist for a formal association with the Laboratory for Atmospheric and Space observations of planetary atmospheres.

To apply, please send a curriculum via and the names and addresses of three references to:

Professor Gary E, Thomas
Department of Astrophysical, Planetary and Atmospheric Sciences

Campus Box, 391

University of Colorado

Boulder, CO 80809

Salary: \$24,000 minimum.

Application deadline: Postmarked no later than March, 15, 1984 (Later applications will be accepted if the position is not filled);

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nell University is an equal opportunity/affir-

Journal of Geophysical Research Volume 69 Number C1 January 20, 1984

Douglay Reed Mat Aveil

Douglay Reed MacAyeal

Peter Steben

Influence of Oceanic Heat Transport Upon the Sensitivity of a Model Climate (Paper 3C1287) M. J. Spelman and S. Monahe

Mesoscale Features Along the 1 rrst Oyashio Intrusion (Paper 3C1555)

M. J. Spelman and N. Monahe

Andrew C. Vastana and Robert 1. Reinstein

Thermobaline Circulation Below the Boss Ice Shell: A Consequence of Infally Induced Vertical Mixing and Basal

Melting (Paper 3C1427)

On the Motion of Suspensed Frank (and Cartest Section 1997)

Turbulent Current Measurements in a Wind-Wave Tank. (Paper 3C1V6)

Jung-Tal Lin and Mehamed God-cl-Hak

Waiter Mixed Layer Entrainment of Weddell Depp Water (Paper 3C1478)

A. J. Gordon, C. J. A. Chen, and W. G. Met. off.
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J. C. Condin, S. F. Ackley, and A. L. Gordon

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A 40- to 60-Day Oscillation in the Source Region of the Somali Current During 1976. (Paper ACLASS)

Lawrence A, Miscal and Gordon J. Mert:
Cold Air Outbreaks Over the Northwest Florida Continental Shelf. Heat Flox Processes and Hydrographic
Changes. (Paper 3C1422)

Changes (Paper 3C1422)

Obear Karl High, Lowerine J. Rome, Jr., and Sun Urlane Walker

Sheedlike Plumes Near a Heated Hottom Plate at Large Rayleigh Number (Paper 3C1644)

Modeling Supercooling and Ice Formation In A Turbulent Ekman Layer (Paper 3C164)

Anders University and Fisher Scrivson

A Note on Linear Surface Wave-Current Interaction Over Slowly Varying Topography (Paper 3C1138)

A note on Linear Surface Wave-Current Interaction Over Slowly Varying Topography (Paper 3C1138)

An Example of Meteorological Effects on the Alboran Sea Gyre (Poper 3C134)

Poul I Thic is and Thomas H. Krider

Comment on "Sea Let Melting in the Marginal Ice Zone," by Telward G. Josberger (Paper 3C128b)

Miles G. Melbier



David A. Woolhiser

The recipient of this year's American Geophysical Union Robert E. Horton Award is: David A. Woodhiser of the U.S. Department of Agenculture's Agricultural Research Service Dr. Woodhiver is Supervisory Research. Hydraulic Engineer and Research Leader for Watershed Hydrology at the Southwest Rangeland Watersheel Research Center in Tueson, Arizona, His academic training was at the University of Wisconsin, where he recrived degrees of Bachelor of Science and Dector of Philosophy, both in Civil Engineering, and at the University of Arizona, where he received an M.S. also in Givil Engineer-

Dr. Woodbisery career has spanned governfacut and academia and his contributions to hydrology have ranged from theoretical developments to practical applications.

He has more than 20 years of service with the U.S. Department of Agriculture and has been on the Lordries of Cornell University. Colorado State University, and the University of Arizona. He is very active in the American. Geophysical Union, the American Society of Cavil Engineers, and the American Society of Agricultural Engineers

Dive's forst major contribution to scientific bydrology was an accurate solution to the shallow water equations with boundary coudsnone appropriate for overland flow. His derivarious of a nondimensional kinematic flow number set forth a criterion for when the kinematic wave formulation can be used in place of the complete flow equations.

This initial contribution was extended in a number of important directions that led to

the development of the kinematic overland flow model into an important hydrological tool. Dave collaborated in obtaining the first solutions to the combined overland flow and infiltration problem, utilizing a partial differential conation for mulation for both phenomena. Additional developments include numerical methods to solve the kinematic wave equations, the formulation and solution of overland flow for converging surfaces, development of a kinematic cascade for surface ranoff, and the formulation of a nonlinear

kinematic wave model for overland flow. Dave has also made important contribu-tions in the application of the kinematic overland flow model to real-world problems.

A major outgrowth of Dave's overland flow research is a better understanding of the impact of spatial variability in catchinent parameters on the outflow hydrograph and his pio-neering work in nonpoint leadings. The impact of Dave's contributions can be

measured by the role kinematic modeling has in hydrology today. Virtually every graduate hydrology curriculum has a course in kinematic modeling. The U.S. Geological Survey's Distributed Routing Rainfall Runoff Model is based upon kinematic overland and channel flow equations and the U. S. Army Corps of Engineer's STORM model has a kinematic model component. The kinematic model is a widely accepted tool in hydrologic consulting.

Thus, it is with great pleasure that I present the 1983 AGU Robert E. Horton Award to Dr. David A. Woolhiser, a scientist and civil servant of the highest merit.

> Peter S. Eagleson AGU Hydrology Section

It is a great pleasure to receive this award. Upon reflecting on my research career in hydrology, it is clear to me that chance and privilege have played a major role leading to

Because chance plays such an important par in hydrologic phenomena, it is, perhaps, appropriate that I entered the field by chance. In my undergraduate program at the University of Wisconsin, I concentrated on the structural option in the Agricultural Engi-neering Curriculum. I did take one course in hydrology, and wrote a B.S. thesis on a hydrologic topic, but I must admit that I really was not particularly excited about the subject. When graduation time came, however, my job offers were both for hydrologic research positions. I accepted a position as instructor with the Agricultural Engineering Department at the University of Arizona, and started work on July 1, 1955, installing raingages

and surveying reservoirs at the Atterbury

Reservoir Watershed east of Tucson, Arizona. During the course of the 3 years that I was associated with this project. I became fascinated with the challenges associated with describing surface runoff phenomena in semiarid regions. It became clear to me that distributed rainfall and runoff models were essential in this regard, and so my career goals were established.

I have been privileged in many ways. First, it has been my privilege to be active in hydrologic research at a time when developments in technology, especially computer technology, made it possible to carry out analyses and to propose models that simply were not feasible before. For example, the works by Lighthill and Whitham and Iwagaki on kinematic waves were published in 1955, and fi-

nite difference techniques were just beginning to be applied to problems in flood routing and hydraulics. My work on the kinematic wave was a natural extension of this and other work. In fact, had computers been available in 1937, Merrill Bernard probably would have developed a distributed model of surface runoff quite similar to those developed in the last decade.

Second, it has also been my privilege to work with a talented group of colleagues. Their contributions, directly or indirectly, cannot be properly acknowledged. However, I would like to name a few, while apologizing o the many left unmentioned. During my stay at Madison and Columbia, Missouri, Neal Minshall impressed upon me the importance of taking great care in collecting hydrologic data and the need to always check the instruments and the calculations. Jim Loggett, at Cornell University, suggested our collabora-tion in the finite difference solution of the shallow water equations, thus inaugurating a very exciting and productive period of re-

I found the environment at Colorado State University to be very stimulating. With people like V. M. Yevjevich, D. B. Simons, H. J. Morel-Seytoux, P. Todorovic, H. W. Shen, D. Dawdy, J. Salas, my ARS colleagues H. Duke, G. Kruse, and P. E. Smith, and an outstanding USGS group in the early days, as well as the many visiting faculty, there were many esciting ideas going around. My collaboration with Petar Todorovic in the stochastic description of daily precipitation and flood phenomena was particularly beneficial in that it gave me a better appreciation for what can be achieved by purely analytic methods as opposed to simulation techniques. As a full-time researcher with ARS, but with offices at the CSU Engineering Research Center, 1 probably had the best of both worlds-the benefit of daily contact with faculty and students without the daily demands of teaching and university committee activities.

Third, it has been my privilege to work with an outstanding group of graduate stu-

dents. Working with them has been the most satisfying aspect of my career. Several have gone on to become prominent in hydrologic research or teaching, including Dave Kibler, Roger Smith, Vijay Singh, and Leonard Lane, to mention a few.

Finally, I would like to express my appreciation to my agency, the Agricultural Research Service of the U.S. Department of Agriculture. Although our research mission is an applied one, our managers recognize that practical applications are often hampered by theo-retical problems, and that individual researchers require considerable freedom to choose areas of research.

To my colleagues, former students, the many aides and technicians who gathered experimental watershed data, and to the secretaries who typed barely legible papers, I would like to dedicate this award. This honor would not have been possible without you.

David A. Woolhise

# Meetings

#### Announcements

#### **Magmatic Evolution**

August 22-26, 1984 Field Conference on Open System Behavior in Magmatic Evolution: Petrological, Geochemical, and Geophysical Constraints, Taos, N. Mex. Sponsor, nstitute for the Study of Earth and Man (ISEM). Information contact: Mike Dungan, Department of Geological Sciences, Southern Methodist University, Dallas, TX 75275; telephone 214-692-2750.

The conference will examine models of open system maginatism in the light of thermal, fluid dynamic, petrologic, geochemical, and isotopic considerations. Included on the schedule are afternoon field trips to volcanic areas near Taos, and morning and evening symposium sessions on such processes as magina mixing and crustal contamination in layered basaltic intrusions, batholiths, and volcanic rocks. Other topics will include phys ical and chemical constraints on the nature of magma chambers, mechanisms of magma migration, and general geochemical modeling techniques.

The application deadline for the conference is February 25, and extended abstracts are due May 1.

The Geophysical Year calendar last appeared in the December 6, 1983, issue. data have an important bearing on petrogenetic tracer studies involving the Lu-Hf isotopic system as well as chronological studies. Hf-2r elemental fractionation may not occur except during extreme fractionation involving tr-minerals at extremely low oxygen fugacity. f systematics)
phys. Res., Farth, Paper 385031

#### Geomagnetism and Paleomagnetism

Paleomagnetism

2500 (Time variations, paleomagnetism)

MAGNETOSTRAITGRAPHY, PALEOMAGNETISM AND PEMAMENCE

ACQUISITION IN THE TRIASSIC CHURGHATER FORMATION OF

WINNING

P.M. Shive (Bapartment of Geology and Geophysics,

Bulversity of Myoming, Laramie, Myoming B2071), M.B.

Steiner and D.T. Muycke

The magnetic reversal sequence determined at five
sections of the Chughater Formation can be corrolated
over a distance of more than 200 km. A detailed study
of 203 cores constituting a grid of samples taken from
a mornal to reverse transition zone at the Red Grade
section shows that the transition is characterized by
a fairly smooth 180° direction change accompanied by
an intensity decrease in about 80 cm of section. The
transition occurs in the same way in all vartical
columns within the grid and in other columns at the
same stratignaphic level up to 80 meters from the
same stratignaphic level up to 80 meters from the
grid, and appears identical to the transition reported
by Herrero-Bervera and Helsley at the same lithologic
horizon about one km from the grid. Thermal and
chemical demagnetization of grid samples removes a
secondary remanence in the general direction of the
earth's present magnetic field and does not reveal the
presence of normal and reverse components in the same
sample. The transition appears to have been magnetized during a reversal of the earth's field. Samples
probably became magnetized in a few hundred years or
lass while they were closs to the deposition surface.
Paleomagnetic pole positions for all five sites are
very closely clustered, and there appears to be no
consistent long term polar wander from bottom to top
in the sections. The mean pole position (46,5%),
113.5% [chagol.80°] agrees well with pole positions
from previous studies of the Chughater Formation.
Taken together, those suggest the possibility of
post-friessic motion of the basement uplifts of

byoulds.

## post-friess... Vygelag. J. Geophys. Res., Earth, Paper 381795 Hydrology

3125 Glaciology A MODIFIED THEORY OF BOTTOM CREVASSES USED AS A MEANS FOR MEASURING THE BUTTRESSING EFFECT OF ICE SHELVES ON

A NODITIED THEORY OF BUTTON CHARMAGE ASSESSMENT AND AND MARKEN THE BUTTERSSING EFFECT OF ICE SHELTES OF MINIAPPIC THE SHELTES OF THE SHE

3130 Broundweter LAMBFILL LEACHATE MIGRATION THROUGH SHALLOW UNCONFINED

AND FILL LEACHATE HIGHATION THROUGH SHALLOW UNCONFINED AQUIFERS
Bavid W. Ostendorf (Civil Engineering Department, University of Ressachusette. Amberst, Massachusetts. 01003), Richard R. Moss, and Devid O. Ledorer
We model the transport of a simply reactive conteminant through a landfill and initially pure, underlying, sheliev, one dimensional, unconfined aquifer with a plans, sloping bottom under steady hydraulic conditions in the assumed absence of dispersion and dommgradient citution. The user population and a presumedly constant contaminant loading factor determine the pollution input to the groundwater system and we model the near field response as a single linear reservoir whose output comprises the far field source term at the dommgradient edge of the landfill. The far field analysis yields a mathod of characteristics solution valid in the vicinity of the source locestion with frome speeds modified by recharge, head loss, bottom slope, and linear easorption, and concentrations reflecting first order reaction kinstics. We calibrate and test the near and far field models against conservative childred end first order reactive blearbonate data at the Babylon, New York landfill with accurace and physically plausible results. (Groundwater contemination, landfill leachato).

Water Resour, Res., Paper 3W1936

TRAINFORT SIMULATION COMBINED WITH NONLINEAR PROCESSIONS

S. H. Gorallok (U. S. Igological Survey, Music Park, California, 94023), C. I. Voss, P. E. dill, W. Burray, H. A. Saundors and H. H. Wright

A simulation-management methodology is demonstrated for the rehabilitation of aquifors that have been subjected to chemical contaminant transport simulation are cubined with nonlinear optimization. The sodal is capable of determining well incetions plus purping and injection rates for groundwater quilty control. Desaples demonstrate linear or nonlinear objective functions subject to linear and nonlinear simulation and water management constraints. Restrictions can be piaced on hydraulic heads, atreases, and gradients, a addition to contaminant congentrations and fivess. Lone can be distributed over space and

en aquifer that is polluted by a constant contaminant source. They are: pumping for contaminant renoval; water injection for in-ground dilution; and a pumping treatment, and injection cycle. A transient model therefore extend the contaminant pione interception or in-quound dilution so that water quality standards are met. The nothed is not limited to these cases. It is generally applicable to the optimization of many types of distributed parameter systems. Mater Besour. Res., Paper 301963

water Resour. Res., Paper 3M1963

3139 (Freelpication)
OPTIMAL ESTIRATION OF THE AVERAGE AREAL RAINFALL
AND OPTIMAL ESTIRATION OF THE AVERAGE AREAL RAINFALL
AND OPTIMAL ESTIRATION OF RAIN-CADOL LOCATIONS,
C. Bestin (Laboratoire d'Automatique, de Dynamiquo
et d'Austige des Sevelbass, Bulvareity of Louvein,
B-1348 Louvein-la-Meuve, Baigium). B. Lorent, C.
Duqué and H. Geover.
A simple procedure for the real-time estimation
of the avorage rainfail to modelled se a 2-disensional random field 18F). The average steal rainfail is computed by a linear umbiased onlimum variance estimation method (Friging) which requires
the knowledge of the variogram of the random field.
A time-varying estimator for the variogram which
takes into aucount the influences of both the asssonal variations and the rainfail intensity is proposed. The average areal rainfail estimator has
been legiseanced in practice. Its application to
real data in two river basins in Baigium is presenred. Finally, it is shown how the method can be
used for the optimal selection of the rain-gauge
locations in a basin.
Water Besour. Res., Paper 3V1935 Water Benour. Res., Paper 3W1935

SI7S Soil moisture
A CROSTATISTICAL APPROACH TO THE EXICELE IRRIGATION
DESIGN IN METEROGENOUS SOIL: 11 A FIELD TEST
David Russo (Division of Soil Physics, Agricultural
Research Organization, The Volcani Center, Bet Dagan,
Israel.

In a heterogeneous field in which the soil properties very, under a 'deterministic' unifors trickle irrigation system, the stdway soil-water pressure head (h<sub>c</sub>), and the yield (f) of a crop also differ from place' to place. Thuse differences may, in turn, reduce the average (over the field) yield, relative to the yield that would be obtained if the soil was unifors throughout the field. A field esperiment was conducted to test the hypothesis that this yield reduction may be sliminated by using a spatially variable trickle irrigation system. Twenty-five plots of Reil pepper (Capaicus frutoscom) var. 'Naor') were established on a 30-m square grid. Helf of each plot was equipped with trickle irrigation system with constant spacing between equipped with trickle irrigation system for which the tween colliers of d=30 cm, and the other helf was equipped with tricis irrigation system for which the spacing between the calters was selected using the pertinent hydraulic properties as described in Part I. It was found that the use of a spatially variable drelative to the use of a uniform d reduced the spatial variable it, increased the integral acaio of he and T by 30h and 10h, respectively, but increased the average fruit yield by only 1.9h. The use of a spatially variable d reduced the dependence of Y on h. This indicates that when the emittern are properly spaced, it is not the water but other factors that each influence yield. Both the theoretical ifart 1) and the experimental results showed that although the each hydraulic properties varied considerably in the field, the spatial variability of the cree yield was relatively smith smith this explains why the use of a spatially-variable d essentially was not an improvement over the fixed d. (Crop yield, soil water pressure head, spatial variability). Water Remodr. Rem., Paper SWIKIS

## Meteorology

Meteorology

3720 Climatology
EFFECTS OF STRATOSPHERIC AEROSOL ON MEASURED SHORT
WAVE RADIATION INCIDEST AT THE GROUND
John J. Carroll (Department of Lond, Air and Water
Resources, University of California, Davis,
California, 95016
Solar radiation measurements taken at Davis,
California, 19516
Solar radiation measurements taken at Davis,
California, 1954 38.5%, 121.8%, 18 m NSL are analyzed
for the effects of known stratospheric aerosol
variation. The data are selected for cloud free
periods with high global transcrissivity, and for tentiangles of bol 2 degrees. These data include the
normal incidence direct, the diffuse and the global
components in the spectral intervals 295-3000 mand
600-3000 mm. Global radiation in the near ultraviolet
(295-400 mm) is also analyzed. The data set begins in
April 1979 and is molyzed through June, 1981
Variations of Lhess data from three year averages are
compared with observed middle northern latitude
stratospheric aerosol variations.
The results are that the global UV radiation
shows short period reductions of 10 to 15% associated
with increased stratospheric aerosol. A decrease in
the maximum received UV to the fourth quarter of each
year is also evident at about 4% per year. The direct
components show 7 to 25% decreases at all wavelengths
during puriods of increased stratospheric aerosol.
The decrease is more peristant at the shorter
wavelengths (A 500 mm) than for the red such mare in
the region. Conversely, the longer wavelength diffuse
region. Conversely, the longer wavelength diffuse
region. Conversely, the longer wavelength diffuse
region. Conversely, the longer baselength graticies.
The global radiation shows relatively small
changes with the praence of stratospheric aerosol,
variability is comparable to the apparent wasonal
variation. Boweser, in 1983, the first quarter global
variation. Soweser, in 1983, the praenuption value and
readistion to be apparent association
in periods with the presence of stratospheric aerosol
to photovoitate electrical power
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J. Geophys. Res., Ocuans, Paper 301969

Reply (Paper 3C1384)

Isotopic Trucers in Polar Seas and Olacier Ice (Paper 3U1768)

Editorial (Paper 3C1903)

Numerical Simulations of the Ross Sea Tides (Paper 3C1414)

On the Motion of Suspended Sand Particles (Paper 3C1667)

TRISTERS LICHTRIS IN NEW MEXTON.
P. Indeed LICHTRIS AND ING. AM. ALICHTRIS LOCAL FACILITY.

Trip and Lisplance experiments with reskets pulling a grounded wire were parliarred at Language Lateracy in 1981. Out of the Lirings Niewest series to a series and the series of the seri

J. Geophys. Res., Atops., Paper 191983

3745 Gravity Makes, fides and Compressional Makes TRANFLING ATMOSPHERSC PRESSURE MAKES PRASURED SURPLY A 10774 SOLAR ECLIFSE IDATELYW. ATMOSPHERIC PRESSURE WAYET "LEGUETO SUPPLY A 101% DOLAR ECLIFSE.

8. A. McIntosh Planetary Comences Perspect Institute.
196(C. Ottawa, Canada) and D. D. Park Her Comparison of Physics and Astronomy. Northern Articol Interestry.
11378367, Articols Senit.
(Airpass, Hines and other, hime bustualist) that the supersonic motion of an eclipse shadow should dead observable effects in the Earth's atmosphere. An array of microbardyraphs with sensitivity O 1 director at 0.1 Hz located near Sackatoon recorded no waves of acoustic velocity at the time of the total solar eclipse of Feb. 26, 1979. There was recorded a three-hour train of subsent pressure wasce with selectly period and amplitude of 10 m/s. 120 s and 120 dyre on respectively. An examination of sossible source machanism leads to the conclusion that these were forced drawity waves caused by the interaction of the eclipse shadow and the low level mocturnal jet (Gravity waves, Low Level Noctural Jets, Solar Eclipses)
1. Geophys. Res., Atmos., Paper 301830

J. Geophys. Res., Atmos., Paper 301830

J. Goophys. Res., Atmos., Paper 301830

JAS Compressional Wavas
PHISTRE WAVE GRMEATED BY THE MOUNT ST. MELENS PROFICE
I. R. Manister fignish Wational Laboratories, Division
JIII, P.O. Box 5003, Albuquarqua, WA, BJISS)
Histories of the air pressure wave radisted from the
sruption of Nount St. Melens on May 18, 1980, wave calculeted for two models of the sruption cloud expansion.
The first considered the wave radisted from an excelersted plane surface white the second examined the wave
radisted from the symmaling hesisphers. Two histories
of supption cloud motion based on photographs were usedfeat positive overpressures were about the same for
these found motion histories if expansion into a hemisphere was assumed. If an accelerated planar source
model was used, the peak positive pressures have again
about the same value in east and west direction but
values are about half in the morth and south direction.
Observed peak overpressures at microbavograph stations
are somewhat higher than the calculated with the most
marked departures at the greater surface ranges. These
observed overpressures may have been about half the
carrect values, however. Pictobarograph records show a
valuer rereflection than calculated bistories or none at
all. This can be explained, to yart, by a lact of area!
atten coherence in the slowing emption cloud. It is
also possible the net ash cloud volume increased considerably after its vertical growth cased and washed the
emptity phase as wall as lengthening the positive phase.
(Volcanology topics)

Geophys. Res., Atmos., Paper 301971 1750 H<sub>2</sub>O in the atmosphere (buildity, clouds, and pre-

ofpication)
WINTIGAL DISTRIBUTION PEATURES OF ATMOSPHERIC WATER C. Tomasi (Intituto FISBAT, C.M.R., Vin de' Castagnoli

Hasburgments of total pracipitable water w and of Hespurgments of total pracipatence water w get or water upper scale beight H water obtained from both sun photosater measurements and soundings taken in the Heisterraneau, Eed Sen, and Indian Ocean, during the scientific croise of the vassel Salerman (January and February 1979). Scale height if was found to same represent the section of 1.93 km for the Mediterranean lag of the cruise, 2.33 km for the Indian Grean, and 2.45 km the fruits. 4.35 to an Committee Coast. Moreover, average for the Red See and Somalian Coast. Moreover, average vertical distribution curves of air temperature, devention and absolute humidity were determined from the oundings taken in an equatorial area of the Indian soundings taken in an equatorial area of the Indian Ocean. This amougheric vater vapor model gives a value of w = 0.12 s cm while the Tropical Model groposad by McClatchey at al. (1972) gives w = 6.20 g cm . In fact, sheelute bondity was found to assume appreciably neclearing the healthy was found to assume appreciably absolute boundity was found to assume appreciably make the front and the first the second density of the second level to about 14 km sittings and resident the second values throughout the tropopules region. The measurements also snow that the pragent evaluations of scale haight H can be conveniently used to represent the absolute bundlity wartical profiles in tropical oceanic areas. (Atmospheric unter wept, procépitable water). J. Geophys. Res., Armos., Paper 101971

1799 Ceneral (Stratospheric Sodien Warmings) A MEMBRICAL TEST OF CORRECTIONS BATHERN THE STRATO-SPRENC SUDDEN MARKING AND THE QUASI-BIERNIAL OSCILLA-

TYON
Allean F.C. Bridger (Department of Meteorology, McGill Paivareity, 805 Sherbrooke Street W., Montreal, P.Q. University, 605 Sherbrooks Street V., Montreal, F.-V. Canada M.J. ZEG) A numerical model of the stratospheric mudden varing is used to test the observationally-based suggestion that the varing is assistive to the phase of the quasi-

Correction to "Chemical Accumulation Variations Under the Peru Cuirent for the Past 194,000 Scars" By F. A. Hoyle, (Paper W1841). Information for Contibutors blenutal regulation in the equatorial. I secretation apports round what field. So or tests show new ottally no sensitivity, within in others so all differences are next between integrations representing the next and most philosometric be nature of an initial formace as we find apport to expert the establishman for nature of an initial results. The presented results notice to consider nor strongly support the observations, but may engest that over the antire white period differences may be satisfied in a constitute sense to give the appointment of a similar strongers, but may engest that support strongers are constituted in the winds. (Attracobaria codes actiones, quartebranchia confliction, resemble codeling)

Edward G. Josherger

.d. Garphys. Pers., D. Poper Wilder

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Analysis of which traditionally on the whole while that contracts and the process and the interest of the anomaly interest anomaly interest of the ano

analysis, imbehr). J. Calphys. Res., D. Paper 400006

3799 General (Earth Hadiation Budget) AN ASSESSMENT OF NIME 13-7 EBB SHORTWAYE SCANNER DATA BY CORRELATIVE ANALYSIS WITH NAKKOWBAND CACS DATA\_

DATA BY CORRELATIVE ANALYSIS WITH NARROWBAND CACS DATA
P.A. Davis (Research & Data Systems, Inc., 10100 Greenbelt Rd., Lanham, MD, 20706), E.R. Major and H. Jecobovitz
Theoretical and amplical relationships between broadband and narrowband radiances are examined to check the post-launch eatherston of the Nimbus-7 Earth Radiation Budget (ERB) shortwave searning channels. The broadband ERB shortwave searning channels radiances and the narrowband Nimbus-7 C&CG channel & radiances were simulated from the University of relative extinute, solar zeruit and setclide zenith angles through several model at 0.09heres. Spectrally-waying relicotances of five basic surface types ivegitation, desert, cloud, water, most) were hindaced as were the spattral response functions of the narrowband intervets. The broadband-narrowband relationships were expressed through linear figgression of broadband against narrowband relationship in our expressed through linear figgressions of actual ERB data in the non-scarsing mode with collected that from CCCS channel & established the empirical broadband-narrowband relations of relationship and enabled a check on the broadband-narrowband relations of relationship and enabled a check on the broadband-narrowband relationship and enabled a check on the broad-and-narrowband relationship and enabled a check on the simulated relationship for a variety of scenes. Since each of the four scanning channels of ERB were compared separately with narrowband data from one sensor, relative differences were accurately determined and adjustments made. Praviously established established adjustment factor. were accurately obtermined and adjantment made. Previously established established adjustment factors for the LkG shortways scanning channels verified in a relative sense, regardless of surface type, to within two percent.

J. Geophyn. Pas., Attain., Va; et 101472

#### Oceanography

'4163 Occasography (Serface vavet, tides, and see level)
QEODTA OF TAMES DI SEALANT VAIRS Stave Piger (A-022,
Rerippa Institution of Consecraphy, University of
Catifornia, La Jolie, CA 92093), R. T. Gott and R. J.

Catifornia, he John, Ca 20033. R. T. Gots and R. J. Seymone

Have group statistics predicted by lister theories are compared to managinal involations, thus determining ranges of spectral shapes for which the theories are valid. It is found that those theories are valid. It is found that those theories are not generally waitd for edeta data because of many samempitions and simplifications happed librarity and random phase, or becames their range of applicability does not inside the vast aspects of occas conditions. The simulations also provide quantitative information about the variability of listar wave group statistics which is madel when emmissing occass field data.

The simulation technique is made in these that important cosm gravity were group statistics are not important cosm gravity were group statistics are not important cosm gravity were group statistics are not important as an involving a war faild acapaced of illoserly superpear's random area. The amportance of illoserly superpear's random area. The majority of the field data samined were collected in 10 m depth; significant wave heights writed from about 20-200 casted the spectral shapes ranged from fairly amove to broad di C Q (6). For the 10, m depth data, the observed made rea laught, variance of run images, and probabilities of runs of a given number of vares acrestatistically constituted with the simulations. It contrast to the apparently linear groups characted in the fairly, waves in 2-1 a depth showed acres departured from the linear simulations. (Naves, wave groups, Essentiance). J. Geuphys. Per., Oceans, Eaper 301930

# GAP

### Separates

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#### Aeronomy

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#### Electromagnetics

The Bontome of the agricult figures of the control of the agreement of the

Optical abservations of a Beau-Planta-Discharge in the laboratory showed that the discharge remained confined to a discrete little core than double that of the beam for injectic, praided to the beginest field and approximately equal to the different of the beam of the server of the discrete day independent of the carried has varied integraly with beam belocity and inversely with the merit field attempt. The loadization rate independent of the beam was propertied to the test and integral from the fail extent of the beam was propertied for the initial extent of the beam was propertied for the initial extension of the beam was propertied for the initial extension of the beam of the required former and of the properties of the test of test of test of the test of test I. Certhen, Pra., Space, Paper 341873

CTTS Paracte Sensing
REFORM SEVENTION, ENGINEERING AND INFORMATION
CONTEST OF COCKIC VARIATIONS
M.El-bacy (Institute of Graduate Studios-UDARC
Chiversity of Alexandria, Alexandria, Egypt), and
I.S. Natiah

Beaute armoing of the prinary compensat of Forte arnoing of the primary expensation of comic flays and distant variations over a wide significant tames in carried out by annium inversion of the Fredholm integral equation a latter decordary variations to the primary appears. But from three and for any invalence are copline functions based in Feynman scaling typethesis. The range of firefatty ever which the retrieval of the primary appears is possible in investigated, information content of the in investigated, information content of results is the primary of the primar

O785 TIC postharic Froragation (Flectro-magnetics)
COMPECTING PATILITY POPPLES DATA FOR TREPGBEHERIC EFFECTA
B. Black the Johns Hopkins University
Aiphled Flysics Laboratory, Johns Hopkins Road,
Learel, Maryland, 2018); A Figner
Using a simple geometrical model, and one
fitted parameter, took spheric effects can be
effectively removed firm anichlist deppler data
at nicroware frequencies. But the west and
dry parts of the tropospheric refraction effect
are removed. The technique works best for low
lear 100 km or least altitude antellites. For
these satellites, the pass (transit) duration
limits the required elementeric correlation
time to about tranty minutes. The effective
for the west and 3 km for the dry limits the
required correlation distance to a few degrees
in latitude and longitude. These conditions

are satisfied often enough to make the fitting technique highly useful.

The fitted parameter together with minimal dependence on model structure appears to skirt a difficult problem; modeling the water vapor distribution in a poorly mixed atmosphera. Experimental results (for a limited time period) confirm that the approach is valid on a global basis.

In another contaxt, this technique can be used to intensively sample the precipitable water vapor in the atmosphere without using balloons. (Geometrical model, doppler data, tropospheric refraction, water vapor.)

J. Geoghys. Res., Alcos., Paper 301948

**Exploration Geophysics** 

OPIO Magnetic and electrical methods
THUE AND APPARENT SPECTRA OF MOTIND POLABIZABLE TARGETS
D. Coptearems (Mailonal Comphysical Manearch Institute,
Uppal Rand, Mydershad 500 007, India)

If the chargesability of a buried target is not
infinitesimal, the popularly used low chargeability
approximation formulated by Haigal (1999) can produce
targe errors in the computation of apparant
approximation, based on a complex, frequency dependent
districtions of the sinium phase shift type this
approximation can be somewhat the place of the for
approximation can be somewhat templified and that for
approximation can be somewhat templified and that for
condispersive host rock, the apparent long-phase spectrum
is only slightly different from a vertically shifted
version of the true phase spectrum of the target.
These results should be useful for the computation of
apparent polarizabilities in numerical moduling for IP,
and in attemps for mineral discrimination through field
measurements of phase spectra.

Chopments, Vol. 49, 80, 2

### Geochemistry

LATO CHARLETY OF the Atmosphere DIVENT AND LINGUESTERN TEMPORAL CHARGES IN THE CONTRICTION OF ATMOSPHERIC PARTICLES AT HAUNA LOA.

C-T-SITION IN ATMOSPHERIC PARTICLES AT MANNA LOA.

INVAIL

JOSEF P. Parrington (Department of Chemistry,
Iniversity of Maryland, Chilege Perk, HD 20742) and

William H. Zollar

The collection of mid-tropospheric atmospheric particulate auter during upslape and downslope mountain
white was accomplished using two types of mector controllers between February 1979 and April, 1982 at Maunn
Loa Ubservatory (HA) on the stand of Hawali. Initially a simple time-of-day system was used for sampling. This was replaced in Pay 1980 by a digital system which monitors between Jesus 1980 by a digital system which monitors between Jesus 1980 by a digital system which monitors between Jesus 1980 by a digital system which monitors between Jesus 20 april 200 by a digital system which may be a will as a standard the same of day to differentiate between
upslope and downstape winds. Farticles derived from
the marine and round standard day for differentiate was 2.50. The mean
ratio being is with single time-of-day control-and 21
with the taprovad and ware discriminating dipical sections lower-in contentration in downslops Winds. The
presence of particles of Warmian beath was determined

by noting its quite different chamical composition as compared with dust transported from continents, over long distances into the area. Local healts appear to be a minor source of crustal particles with concentrations of local baselt at MLO estleated to be 15 mg/m<sup>3</sup> ( $\sigma_g = 1.3$ ) in downslope winds we, 87 mg/m<sup>3</sup> ( $\sigma_g = 2.6$ ) in samples collected under upslope conditions. After correction for this local crustal material, the upslope/downslope crustal dust ratio still tenained high (2.2) and exhibited atrong easemel variations, being much lower between mid-Pebruary to July (1.2) when high concentrations of dust are transported from Asian deserts to Esweii, than during the remainder of the year (3.2). Upslope sulfate concentrations everaged 1.7 times higher than downslope conditions at MLO (350 mg/m<sup>3</sup>,  $\sigma_g = 1.9$ , we 340 mg/m<sup>3</sup>,  $\sigma_g \approx 2.0$ ). (atmospheric composition hackground abroadles, sountain vinds, Hawa(1)

1490 Instruments and Tachniques (Infrared Reflectance)
RAFID DISCRIBILISATION OF GRANITIC ROCK COMPOSITIONS BY
ALOW ARE SHIP (Galley Department, Fomons College,
Claremont, California, 91711) Claremone, California, 91711)
The slopes of near-infrared spectra between - 1 and - 2 yes from quarts-bearing plutonic rocks are arrows. The Scope or mear-infrared spactra between ~ 1 and ~ 2 pm from quarts-bearing plutonic rocks are strongly correlated with rock chemistry determined by X-ray spectromorty. The predictive quantions derived empirically provide compositional data of adequate precision and resolution to discorp patterns of regional geochemical variation in granitic butholithic tacks of southern California. As an analytical mathod, infrared spectrometry is rapid and inexpensive, and the mathod has potential in applications to direct lield secarrometry and to data from aircraft and appaceraft scanner systems of relatively low spectral and spatial resolution, provided vagetative cover and surface alteration era not prohibitively masking. (Regr-infrared, genific rocks, rock discrimination).

1499 General (Fartition Coefficients)
PARTITION COEFFICIENTS OF Hf. Zr. AND REE
BETWEEN PHENCAYSTS AND GROUNDMARSES
H. FUJIMAKI (USGS, MS 963, BOX 25046, DFC,
DENVER CO B0225). H. TATSUMOTO and K. AOKI
Partition coefficients of Hf. Zr. and REE
hetween olivine, orthopyroxene, plagioclase,
garnet, amphibole, ilmenits, phlocopite, and
idquid have been determined, Samplas consisted
of megacrysts in kimberlite; phenocrysts in
aikaline basalts, tholastic basalts, and
garnet and clinopyroxene in a rock of Hawaisan,
tholastic to dactic rocks, and synthetic
garnet and clinopyroxene in a rock of Hawaisan
tholastic composition. The Hf and Zr partition
coefficients between maric phenocrysts and
iquids are smaller than the Lu partition
coefficients and are similar to the Hd or Bé
partition coefficients. In particular, the Lu
partition coefficient between garnet and liquid
is much larger than the Hf partition
coefficient, on the other hand, the Hf and Zr
partition coefficients, for those minerals,
phlogopite, and liquid are larger than the Lu
partition coefficients, for those minerals.
Because ilmenite probably played an important
role in forming the lumar high-Ti mare basalt
constituent in terrestrial magma, sources, these

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